

 **national science week 2014**

**16-24 AUGUST [www.scienceweek.net.au](http://www.scienceweek.net.au)**

**FOOD FOR OUR FUTURE**

**Science feeding  
the world**

**A RESOURCE BOOK OF IDEAS FOR  
NATIONAL SCIENCE WEEK 2014**



An Australian Government Initiative





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## SAFETY AWARENESS

**All activities included in *Food for our future: Science feeding the world* have been designed or selected to minimise hazards. However, there is no guarantee that a procedure will not cause injury. Teachers and community educators need to be aware of the special considerations surrounding practical activities in the classroom and ensure that students are suitably clothed for outdoor experiences. Teachers and community educators should test all activities before using them in class and observe the OH&S requirements of their own state or territory. All necessary safety precautions should be outlined clearly to students prior to the commencement of any activity.**

### Acknowledgements

#### Authors of lessons:

Years F–2: Narinda Sandry  
Years 3–5: Shelley Murphy  
Years 6, 8: Kate Dilger  
Years 7, 9, 10: Helen Silvester

#### Design, layout and background information:

Coretext, [www.coretext.com.au](http://www.coretext.com.au)  
T: +61 3 9670 1168, E: [admin@coretext.com.au](mailto:admin@coretext.com.au)

#### Publisher:

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PO Box 334,  
Deakin West ACT 2600

# PRESIDENT'S MESSAGE

ASTA is delighted to bring you the 2014 ASTA National Science Week web-based digital resource book 'Food for our future: Science feeding the world'. It is designed for teachers and community educators who will find it a most useful resource for teaching year F-10 students about food choices, food production and food security – all with an Australian focus.

The resource book will assist you in planning for National Science Week 2014 but will also be a useful ongoing resource. For the first time the resource book is fully mapped to the Australian Curriculum: Science and has a full lesson plan for each year level. This is meant to provide teachers with inspiration to plan additional lessons depending on their needs using the 'Food for our future' curriculum map.

I hope you enjoy the new approach to this year's resource book. It has been written by educators for educators and I warmly thank all involved in its production.

ASTA would like to acknowledge the funding support for this resource from the Australian Government through the Inspiring Australia Initiative and also acknowledge the eight state and territory Science Teachers Associations and their National Science Week representatives for their ongoing support of National Science Week in schools at the local level.

**Robyn Aitken, ASTA President**





# MINISTER'S FOREWORD

## THE SCIENCE THAT SUSTAINS US ALL

The science of food production is one of Australia's most important fields of research, encompassing sophisticated farming and environmental management through to ongoing advances in food processing technologies, nutrition and food safety.

This is a broad field of research that brings together a wide spread of scientific disciplines—from areas such as genetics and microbiology through to engineering, physics, chemistry, mathematical modelling and materials science.

Food production and agriculture in Australia is a modern, state-of-the-art sector of the Australian economy and is a very appropriate theme for National Science Week in schools, particularly given our proud history of agricultural and aquaculture innovation and our contemporary food industries that are opening up exciting futures.

As a former farmer myself I appreciate the role that science plays in making our food production not only sustainable from the perspective of our land and ocean resources, but globally competitive in hard-earned export markets.

Much has been said about Australia's potential as a food producer for Asia. Rising living standards in our neighbouring countries is broadening people's diets and increasing their demand for high quality fresh food, and for processed foods that offer improved convenience, quality and product safety. This fundamental economic shift is just one of many new challenges and opportunities for our food industries, for the research community and, significantly, for today's science students for whom food and agriculture presents such extraordinary scope and variety.

We owe much to the professionalism of our food and agriculture sector and the dedicated researchers who keep its systems and technologies at the international forefront.

I am particularly pleased that National Science Week is recognising this achievement and encouraging a new generation of scientists to build on this legacy and ensure these vital industries continue to sustain our communities and economies long into the future.

**The Hon Ian Macfarlane MP**  
*Minister for Industry*



# INTRODUCTION

The schools theme for National Science Week 2014 is **Food for our future: Science feeding the world**. The theme was inspired by the International Year for Family Farming. This book has been designed to provide teachers and community educators with a selection of lesson plans and further activity ideas to enhance their students' knowledge and understanding of the science of food—food production, processing, security and nutrition.

## HOW THIS BOOK IS STRUCTURED

### Food for our future curriculum map:

ASTA has developed an abbreviated curriculum map of the Australian Curriculum: Science F-10. This has been used to develop a curriculum map of food topics. For each year level and against every content description in the Science Understanding and Science as a Human Endeavour sub-strands topic ideas have been specified that complement the 'Food for our future: Science feeding the world' theme. These are provided as a stimulus for teachers to develop lessons/units related to the topics and to suit their own needs.

### Lesson plans:

For each year level, a content description and topic was chosen and developed into a full lesson plan. The book contains eleven lessons, one for each year, F–10. Teachers may choose to use the lesson relevant to their year level and/or develop a similar one using a different/complementary content description. Relevant content descriptions from the Science Inquiry sub-strand are included in all the lessons.

The eleven lessons have been prepared using the same structure giving the teacher all the information needed to prepare for and conduct the lesson. Each lesson has:

- an introduction
- a list of the relevant Australian Curriculum: Science content descriptions and codes. Each code is hyperlinked to the ACARA website.
- reference to the relevant assessment standard/s
- brief background information
- materials and equipment list
- safety advice (if relevant)
- a teaching sequence
  - Lesson objective
  - Introduction
  - Core
  - Conclusion
- lesson resources – could include digital resources and/or worksheets
- useful links to websites for more information or additional activities.

A page of interesting background information for teachers prefaces each lesson. This provides some context for the topic and in most cases incorporates references to Australian food science and innovation.



# CURRICULUM MAP

National Science Week 2014 | Food for our future: Science feeding the world

## SCIENCE UNDERSTANDING — BIOLOGICAL SCIENCES; CHEMICAL SCIENCES

Year	Biological Sciences			Chemical Sciences	
	Structure and function	Diversity and evolution	Interdependence	Properties and structure	Interaction and change
<b>F</b>			<b>ACSSU002: Living things have basic needs, including food and water</b> <ul style="list-style-type: none"> <li>Needs of young lambs: milk from their mother ewe</li> <li>Needs of wheat seedlings: water and food (fertiliser)</li> </ul>	<b>ACSSU003: Objects are made of materials that have observable properties</b> <ul style="list-style-type: none"> <li>Taste and describe different flavoured milks</li> <li>Taste and describe the differences between apples, oranges and bananas</li> <li><b>What's in your lunch box?</b></li> </ul>	
<b>1</b>	<b>ACSSU017: Living things have a variety of external features</b> <ul style="list-style-type: none"> <li>Describe the identifying features of cattle, ducks, dogs, sunflowers and apple trees</li> </ul>		<b>ACSSU211: Living things live in different places where their needs are met</b> <ul style="list-style-type: none"> <li>Needs of young calves: protection by their mothers and farmers</li> <li>Needs of strawberry plants: farmers provide water, shelter and fertiliser</li> <li>Needs of bees: apiarists provide shelter and sugar solution during winter</li> </ul>		<b>ACSSU018: Everyday materials can be physically changed in a variety of ways</b> <ul style="list-style-type: none"> <li>Describe the differences between bread and toast as well as fresh and cooked apples</li> </ul>
<b>2</b>	<b>ACSSU030: Living things grow, change and have offspring similar to themselves</b> <ul style="list-style-type: none"> <li>Describe the physical development of lambs and calves into mature adults</li> <li>Describe the physical development of broad bean seedlings into mature plants</li> </ul>			<b>ACSSU031: Different materials can be combined, including by mixing, for a particular purpose</b> <ul style="list-style-type: none"> <li>Make a salad dressing (a mixture?) of (balsamic) vinegar and olive oil</li> </ul>	
<b>3</b>		<b>ACSSU044: Living things can be grouped on the basis of observable features and can be distinguished from non-living things</b> <ul style="list-style-type: none"> <li>List the living and non-living things on a local farm.</li> <li>How many food crops are grown in your area and your State? How many of them do you eat?</li> <li>How many different types of meats are sold in your supermarket?</li> </ul>		<b>ACSSU046: A change of state between solid and liquid can be caused by adding or removing heat</b> <ul style="list-style-type: none"> <li>At what temperatures do different ice-creams and fruit gelatos melt?</li> <li><b>Which chocolate melts fastest? White, brown or dark?</b></li> </ul>	



## SCIENCE UNDERSTANDING — BIOLOGICAL SCIENCES; CHEMICAL SCIENCES

Year	Biological Sciences			Chemical Sciences	
	Structure and function	Diversity and evolution	Interdependence	Properties and structure	Interaction and change
4	<b>ACSSU072: Living things have life cycles</b> <ul style="list-style-type: none"> <li>Which came first, the chicken or the egg?</li> <li>Visit a young animal pavilion in your agricultural show.</li> </ul>		<b>ACSSU073: Living things, including plants and animals, depend on each other and the environment to survive</b> <ul style="list-style-type: none"> <li>List all the living things that make up a local farm (from a worm to a farmer), and show their interconnections.</li> </ul>	<b>ACSSU074: Natural and processed materials have a range of physical properties; These properties can influence their use</b> <ul style="list-style-type: none"> <li>Air-dry some local fruits and compare the characteristics between the fresh and dried fruit.</li> </ul>	
5	<b>ACSSU043: Living things have structural features and adaptations that help them to survive in their environment</b> <ul style="list-style-type: none"> <li>How does the soil type and climate effect what type of farming is carried out in your area and a different State?</li> </ul>			<b>ACSSU077: Solids, liquids and gases have different observable properties and behave in different ways</b> <ul style="list-style-type: none"> <li>Gases are used in food production in agriculture to increase crop yields (CO<sub>2</sub> in drip irrigation, greenhouse enrichment).</li> <li>Gases are used in food preservation in agriculture to destroy pests (CO<sub>2</sub> in grain silos) and preserve fruit (CO<sub>2</sub> to reduce the percentage of ethylene).</li> <li>Describe examples of gaseous, liquid and solid fertiliser used to increase food crop yield.</li> </ul>	
6	<b>ACSSU094: The growth and survival of living things are affected by the physical conditions of their environment</b> <ul style="list-style-type: none"> <li>Investigate the effect of saline soils, different fertilisers and drainage on the yield of food crops.</li> </ul>			<b>ACSSU095: Changes to materials can be reversible, such as melting, freezing, evaporating; or irreversible, such as burning and rusting</b> <ul style="list-style-type: none"> <li>How is dairy effluent treated to make it safe to irrigate pastures?</li> </ul>	
7	<b>ACSSU111: There are differences within and between groups of organisms; classification helps organise this diversity</b> <ul style="list-style-type: none"> <li>Different cattle breeds respond to different conditions.</li> </ul>		<b>ACSSU112: Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions</b> <ul style="list-style-type: none"> <li>Sustainable fishing</li> </ul>	<b>ACSSU113: Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques</b> <ul style="list-style-type: none"> <li>Making butter</li> </ul>	
8	<b>ACSSU149: Cells are the basic units of living things and have specialised structures and functions</b> <ul style="list-style-type: none"> <li>Plant cells producing antioxidants (fruits)</li> </ul> <b>ACSSU150: Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce</b> <ul style="list-style-type: none"> <li>Effective germination for food crops</li> <li>Photosynthesis: N for leaf growth, P for roots and fruit, K for flowers</li> </ul>			<b>ACSSU151: The properties of the different states of matter can be explained in terms of the motion and arrangement of particles</b> <ul style="list-style-type: none"> <li>Osmosis, diffusion, molecular motion and fresh cherries</li> </ul> <b>ACSSU152: Differences between elements, compounds and mixtures can be described at a particle level</b> <ul style="list-style-type: none"> <li>Aquatic Air, Measuring dissolved oxygen</li> <li>Agricultural chemicals: Interactive Molecular Visualiser</li> </ul>	<b>ACSSU225: Chemical change involves substances reacting to form new substances</b> <ul style="list-style-type: none"> <li>Using Polyacrylamide for water retention in soils</li> <li>Fermentation &amp; Brewing</li> <li>Nitrogen cycle, fertilisers and food production</li> </ul>





## SCIENCE UNDERSTANDING — BIOLOGICAL SCIENCES; CHEMICAL SCIENCES

Year	Biological Sciences			Chemical Sciences	
	Structure and function	Diversity and evolution	Interdependence	Properties and structure	Interaction and change
9	<p><b>ACSSU175: Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment</b></p> <ul style="list-style-type: none"> <li>Development of drought resistant crops</li> <li>Photosynthesis and Light Intensity</li> <li>Adapting agricultural practices/crops to climate changes eg Cotton</li> <li>Induction of spawning of oysters</li> </ul>			<p><b>ACSSU176: Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems</b></p> <ul style="list-style-type: none"> <li>Farming ecosystem</li> <li>Building soil carbon</li> <li>Effect of soil pH and salinity on agricultural ecosystems</li> <li>Biodiversity and sustainable food production</li> <li><b>Growing food on the space station</b></li> </ul>	
				<p><b>ACSSU177: All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms</b></p> <ul style="list-style-type: none"> <li>Molecular structure of essential oils Insecticides in Cotton</li> <li>Agricultural chemicals: Interactive Molecular Visualiser</li> <li>Introduction of Organic Chemistry</li> </ul>	
10	<p><b>ACSSU184: The transmission of heritable characteristics from one generation to the next involves DNA and genes</b></p> <ul style="list-style-type: none"> <li>Plant breeding v's GMOs</li> <li>Researching lipids found in different seeds to increase consumer health</li> <li>Weed control and herbicide resistance</li> <li>Extraction and analysis of beef DNA</li> <li>BT Cotton</li> <li>Identifying foreign fish in our market place</li> </ul> <p><b>ACSSU185: The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence</b></p> <ul style="list-style-type: none"> <li>Simulation of population genetics and natural selection in an aquatic ecosystem</li> <li><b>The evolution of wheat</b></li> </ul>			<p><b>ACSSU186: The atomic structure and properties of elements are used to organise them in the Periodic Table</b></p> <ul style="list-style-type: none"> <li>Trace elements required for effective growth of different crops</li> <li>SO<sub>2</sub> in the wine industry; equilibrium</li> </ul>	
				<p><b>ACSSU178: Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed</b></p> <ul style="list-style-type: none"> <li>Cheese making</li> <li>Effect of enzyme lactase on lactose concentration in milk</li> <li>Determine the role of enzymes in Food Science</li> </ul> <p><b>ACSSU179: Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer</b></p> <ul style="list-style-type: none"> <li>Soil pH and its effect on nutrient availability</li> <li>Acid soils and effect on food production</li> <li>Fruit storage: Effect of ethylene</li> <li>Production of Malt</li> </ul>	
				<p><b>ACSSU187: Different types of chemical reactions are used to produce a range of products and can occur at different rates</b></p> <ul style="list-style-type: none"> <li>Wine production</li> <li>Alcohol production</li> <li>Wine faults</li> <li>Fungal control in wheat crops by testing different treatments</li> <li>Determination of ascorbic acid in fruit and vegetables</li> <li>Food crops or Biodiesel</li> </ul>	



## SCIENCE UNDERSTANDING – EARTH AND SPACE SCIENCES; PHYSICAL SCIENCES

Year	Earth and space sciences		Physical sciences	
	Systems in space	Changes to the Earth	Transformation and conservation of energy	Forces and motion
<b>F</b>		<b>ACSSU004: Daily and seasonal changes in our environment, including the weather, affect everyday life</b> <ul style="list-style-type: none"> <li>What time of the year are food crops grown in your area?</li> </ul>		<b>ACSSU005: The way objects move depends on a variety of factors, including their size and shape</b> <ul style="list-style-type: none"> <li>Movement of seeds by wind (dandelion) and falling (wattle) is determined by size and shape</li> </ul>
<b>1</b>		<b>ACSSU019: Observable changes occur in the sky and landscape</b> <ul style="list-style-type: none"> <li>Talk about the different farms in your local area</li> <li>Measure the rainfall in your area and mark the rainy days on a calendar</li> </ul>	<b>ACSSU020: Light and sound are produced by a range of sources and can be sensed</b> <ul style="list-style-type: none"> <li>Identify the sounds of cows and calves, sheep and lambs as well as hens and chickens</li> <li>Grow wheat seeds in the dark and in the light</li> </ul>	
<b>2</b>		<b>ACSSU032: Earth's resources, including water, are used in a variety of ways</b> <ul style="list-style-type: none"> <li>How is water used to grow food in your area?</li> <li><b>Healthy soil, healthy living</b></li> </ul>		<b>ACSSU033: A push or a pull affects how an object moves or changes shape</b> <ul style="list-style-type: none"> <li>Need a different push to move toy tractors up and down a slope, and on the level</li> </ul>
<b>3</b>	<b>ACSSU048: Earth's rotation on its axis causes regular changes, including night and day</b> <ul style="list-style-type: none"> <li>Show the importance of sunlight in the growth of a local food crop.</li> </ul>		<b>ACSSU049: Heat can be produced in many ways and can move from one object to another</b> <ul style="list-style-type: none"> <li>Measure the different temperatures of white sand, brown and black soils.</li> <li>How does soil temperature effect the germination of grass, wheat and sweetcorn.</li> </ul>	
<b>4</b>		<b>ACSSU075: Earth's surface changes over time as a result of natural processes and human activity</b> <ul style="list-style-type: none"> <li>Collect different soil types and ask a farmer which is best for which crop.</li> </ul>		<b>ACSSU076: Forces can be exerted by one object on another through direct contact or from a distance</b> <ul style="list-style-type: none"> <li>Use a piece of tyre to compare and contrast the friction on concrete, gravel and wet soil.</li> </ul>
<b>5</b>	<b>ACSSU078: The Earth is part of a system of planets orbiting around a star (the sun)</b> <ul style="list-style-type: none"> <li>Describe how the sun is the essential ingredient to grow food crops and animals.</li> </ul>		<b>ACSSU080: Light from a source forms shadows and can be absorbed, reflected and refracted</b> <ul style="list-style-type: none"> <li>Germinate and grow wheat seeds under different coloured lights.</li> <li>What colour of light is reflected from cereal leaves?</li> <li><b>Investigating factors that influence seed germination and plan growth.</b></li> </ul>	
<b>6</b>		<b>ACSSU096: Sudden geological changes or extreme weather conditions can affect Earth's surface</b> <ul style="list-style-type: none"> <li><b>Drought-proof soils</b></li> </ul>	<b>ACSSU097: Electrical circuits provide a means of transferring and transforming electricity</b> <ul style="list-style-type: none"> <li>Report on ways in which scientists use electrical circuits to measure salt and pH in soil on a farm?</li> </ul> <b>ACSSU219: Energy from a variety of sources can be used to generate electricity</b> <ul style="list-style-type: none"> <li>What ways can electricity be generated on the farm?</li> </ul>	





## SCIENCE UNDERSTANDING – EARTH AND SPACE SCIENCES; PHYSICAL SCIENCES

Year	Earth and space sciences		Physical sciences	
	Systems in space	Changes to the Earth	Transformation and conservation of energy	Forces and motion
7	<b>ACSSU115:</b> Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon ▪ Plan a seasonal sowing guide for a garden	<b>ACSSU116:</b> Some of Earth's resources are renewable, but others are non-renewable ▪ Soils are non-renewable, what strategies do farmers use to minimise soil loss? <b>ACSSU222:</b> Water is an important resource that cycles through the environment ▪ How does the farmer conserve water for his crops and animals?		<b>ACSSU117:</b> Change to an object's motion is caused by unbalanced forces acting on the object ▪ What are the major reasons why "Quad Bikes" have fatal accidents? <b>ACSSU118:</b> Earth's gravity pulls objects towards the centre of the Earth ▪ Describe the difficulties in growing food crops in zero gravity. What would be the solutions?
8		<b>ACSSU153:</b> Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales ▪ Use of limestone and dolomite to condition cropping soils	<b>ACSSU155:</b> Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems ▪ Wind farms – friend or foe?	
9		<b>ACSSU180:</b> The theory of plate tectonics explains global patterns of geological activity and continental movement ▪ Different rock formation processes generate different landforms, that produce different soil types, that determine the local agriculture	<b>ACSSU182:</b> Energy transfer through different mediums can be explained using wave and particle models ▪ Optimising energy in a glasshouse system ▪ Growing food on the space station.	
10	<b>ACSSU188:</b> The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin the universe ▪ Sustainable agriculture in space colony	<b>ACSSU189:</b> Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere ▪ Water cycle and crops ▪ Carbon footprint of the dairy industry	<b>ACSSU190:</b> Energy conservation in a system can be explained by describing energy transfers and transformations ▪ Satellite imagery to determine crop health	<b>ACSSU229:</b> The motion of objects can be described and predicted using the laws of physics ▪ Tractor stability on different surfaces, towing different implements

## SCIENCE AS A HUMAN ENDEAVOUR

Year	Nature and development of science	Use and influence of science
F	<b>ACSHE013:</b> Science involves exploring and observing the world using the senses ▪ Observe sunflower seeds germinating in a glass jar or saucer ▪ Explore how earthworms aerate and mix soil	
1	<b>ACSHE021:</b> Science involves asking questions about, and describing changes in, objects and events ▪ What happens when wheat seeds germinate? ▪ Sugar detectives	<b>ACSHE022:</b> People use science in their daily lives, including when caring for their environment and living things ▪ Caring for growing cress and mustard as micro herbs ▪ Sugar detectives
2	<b>ACSHE034:</b> Science involves asking questions about, and describing changes in, objects and events ▪ What happens when milk is left out of the fridge?	<b>ACSHE035:</b> People use science in their daily lives, including when caring for their environment and living things ▪ Caring for yourself: eating healthy foods
3	<b>ACSHE050:</b> Science involves making predictions and describing patterns and relationships ▪ How much salt needs to be dissolved in water to make fresh eggs float?	<b>ACSHE051:</b> Science knowledge helps people to understand the effect of their actions ▪ Why is it important to eat fruit and vegetables?
4	<b>ACSHE061:</b> Science involves making predictions and describing patterns and relationships ▪ Which chocolate melts first, white, brown or dark?	<b>ACSHE062:</b> Science knowledge helps people to understand the effect of their actions ▪ Develop a healthy Food Pyramid for your family.



## SCIENCE AS A HUMAN ENDEAVOUR

Year	Nature and development of science	Use and influence of science
5	<p><b>ACSHE081:</b> Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena</p> <ul style="list-style-type: none"> <li>What conditions will grow the most mould on bread?</li> </ul> <p><b>ACSHE082:</b> Important contributions to the advancement of science have been made by people from a range of cultures</p> <ul style="list-style-type: none"> <li>Find out about the Rotary Food Plant Solutions (<a href="http://www.learnngrow.org">www.learnngrow.org</a>)</li> </ul>	<p><b>ACSHE083:</b> Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives</p> <ul style="list-style-type: none"> <li>What are the advantages and disadvantages of self driving tractors?</li> </ul> <p><b>ACSHE217:</b> Scientific knowledge is used to inform personal and community decisions</p> <ul style="list-style-type: none"> <li>What are the best conditions to improve growth of local food crops?</li> </ul>
6	<p><b>ACSHE098:</b> Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena</p> <ul style="list-style-type: none"> <li>Which developed the greatest amount of mould, uncooked or cooked food?</li> <li>What are the best storage conditions to prevent potatoes sprouting?</li> </ul> <p><b>ACSHE099:</b> Important contributions to the advancement of science have been made by people from a range of cultures</p> <ul style="list-style-type: none"> <li>Research the "Green Revolution (1940-1960)" and the countries involved.</li> </ul>	<p><b>ACSHE100:</b> Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives</p> <ul style="list-style-type: none"> <li>How does a robot milk cows? What are the advantages and disadvantages of a robotic dairy? (<a href="http://www.scenicrim4realmilk.com.au">www.scenicrim4realmilk.com.au</a>)</li> </ul> <p><b>ACSHE220:</b> Scientific knowledge is used to inform personal and community decisions</p> <ul style="list-style-type: none"> <li>Find out about your local "Farmers Market". Talk to the stall holders about how they use science to produce their food.</li> </ul>
7	<p><b>ACSHE119:</b> Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world</p> <ul style="list-style-type: none"> <li>What are the important aspects for the success of sustainable food production in your area?</li> </ul> <p><b>ACSHE223:</b> Science knowledge can develop through collaboration and connecting ideas across the disciplines of science</p> <ul style="list-style-type: none"> <li>Describe some of the international collaborations established by the UWA Institute of Agriculture (<a href="http://www.ioa.uwa.edu.au">www.ioa.uwa.edu.au</a>)</li> </ul>	<p><b>ACSHE120:</b> Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations</p> <ul style="list-style-type: none"> <li>Describe ways in which agricultural food crop pests are controlled in Australia.</li> </ul> <p><b>ACSHE121:</b> Science understandings influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management</p> <ul style="list-style-type: none"> <li>Research the different scientific controls used to control rabbits in Australia.</li> </ul> <p><b>ACSHE224:</b> People use understanding and skills from across the disciplines of science in their occupations</p> <ul style="list-style-type: none"> <li>Which branches of science work together to develop a sustainable management of water use in farms?</li> </ul>
8	<p><b>ACSHE134:</b> Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world</p> <ul style="list-style-type: none"> <li>How does biodiversity improve sustainability of food production in different countries?</li> </ul> <p><b>ACSHE226:</b> Science knowledge can develop through collaboration and connecting ideas across the disciplines of science</p> <ul style="list-style-type: none"> <li>Investigating meat tenderness</li> </ul>	<p><b>ACSHE135:</b> Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations</p> <ul style="list-style-type: none"> <li>Using Polyacrylamide for water retention in soils</li> </ul> <p><b>ACSHE136:</b> Science understandings influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management</p> <ul style="list-style-type: none"> <li>Describe how technologies have been applied to modern farming techniques to improve yields and sustainability.</li> </ul> <p><b>ACSHE227:</b> People use understanding and skills from across the disciplines of science in their occupations</p>
9	<p><b>ACSHE157:</b> Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community</p> <ul style="list-style-type: none"> <li>Fungal control in wheat crops by testing different treatments</li> </ul> <p><b>ACSHE158:</b> Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries</p> <ul style="list-style-type: none"> <li>Developing lactose free milk</li> <li>Adapting agricultural practices/crops to climate changes eg cotton</li> </ul>	<p><b>ACSHE160:</b> People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions</p> <ul style="list-style-type: none"> <li>Determine the role of enzymes in Food Science</li> </ul> <p><b>ACSHE161:</b> Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities</p> <ul style="list-style-type: none"> <li>Effect of soil pH and salinity on agricultural ecosystems</li> </ul> <p><b>ACSHE228:</b> The values and needs of contemporary society can influence the focus of scientific research</p> <ul style="list-style-type: none"> <li>Fish stocking to help recovery of populations at risk</li> </ul>
10	<p><b>ACSHE191:</b> Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community</p> <ul style="list-style-type: none"> <li>Stud beef cattle parentage testing by DNA marker technology</li> <li>DNA computer modelling for determining bacterial spoilage of meat</li> </ul> <p><b>ACSHE192:</b> Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries</p> <ul style="list-style-type: none"> <li>Weed control and herbicide resistance</li> </ul>	<p><b>ACSHE194:</b> People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions</p> <ul style="list-style-type: none"> <li>Determine the role of enzymes in Food Science</li> </ul> <p><b>ACSHE195:</b> Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities</p> <ul style="list-style-type: none"> <li>Soil pH and salinity on agricultural ecosystems</li> </ul> <p><b>ACSHE230:</b> The values and needs of contemporary society can influence the focus of scientific research</p> <ul style="list-style-type: none"> <li>Researching lipids found in different seeds to increase consumer health</li> <li>Developing different cereals to produce gluten free bread</li> </ul>



# WHOLEFOODS VS PROCESSED FOODS

As recently as 100 years ago, the average person's diet was determined by the capacity to grow, kill or gather. Our forebears ate only 'wholefoods': primarily fruits, vegetables, grains, unpasteurised butter, milk and cheese, meat, fish and eggs.

However, from the early 20th century our food supply has been increasingly industrialised. The advent of food manufacturing increased the amount of food available but often at the expense of nutrition.

In their natural state – unprocessed and unrefined – wholefoods are rich in vitamins, minerals and dietary fibre, and contain the four essential nutrients – water, carbohydrates, fat and protein. However, wholefoods typically require longer preparation times than processed foods and have shorter shelf lives.

Processed foods result from manufacturing methods such as pasteurisation, fermentation, milling, canning, salting and freezing. These methods convert raw ingredients into packaged goods that have a longer shelf life (preservation), are free of pathogens and toxins (food safety), can be prepared quickly (convenience) and have an altered flavour, texture, aroma, colour or form (variety).

Intensive processing usually depletes valuable nutrients. Grain, for example, tends to be a nutritional impersonator of its wholegrain self, stripped of its most nutritious components – the bran and germ.

Processed foods such as breakfast cereals, breads, processed meats, biscuits, ice cream, fast foods and soft drinks are often high in sugar, salt and saturated or trans fats. They contain almost no dietary fibre and are stacked with artificial flavours, preservatives, hydrogenated oil, fillers and sweeteners.

The World Health Organization believes the amount of processed foods consumed is responsible for increasing levels of obesity, diabetes and coronary disease.

Some food manufacturers are compensating for nutrient losses by fortifying – for example, by adding vitamin D to milk or folic acid to grain-based foods. But studies have shown that synthetic nutrients are less bio-available to the body than natural foods.

The conundrum is that there is more manufactured food in stock than at any time in human history, yet the planet is facing a food crisis. A major push has started to steer agriculture and consumer trends towards 'functional foods' – natural food products that simultaneously address the diet-related health issues in developed countries and lift crop production in countries facing food shortages.

Examples of functional foods are whole grains and pulses (peas, beans, legumes), which provide the body with micronutrients that research has shown can actively protect against disease, including heart disease and some cancers. For communities needing to lift food production, pulses transfer nitrogen from the air to the soil, improving crop yields.



## DID YOU KNOW:

- The five unhealthiest foods you can consume are doughnuts, soft drink, commercially fried foods such as French fries, and fried non-fish seafood.
- A good way to recognise highly processed foods is if the label ingredients number more than five and are unfamiliar.





Lesson plan: Year F

# WHAT'S IN YOUR LUNCH BOX?

## Introduction

The understandings that objects are made of materials that have observable properties, and that we can explore and observe these properties using our senses, are important scientific principles for Foundation students. Supermarket food provides a valuable real-life context for such learning. Young children may be familiar with the idea of eating healthy foods but being able to identify healthy foods over less healthy choices is difficult, even for adults. Misleading labels can add to the confusion. Understanding why some types of foods are a poor choice is an important step in taking care of ourselves and preventing illnesses such as obesity and Type 2 diabetes.

In this lesson, students learn that some foods are natural (wholefoods) and some foods are man-made (processed). Students explore foods using their senses to examine their properties (including taste) and their ingredients. Students learn that processed supermarket foods have a list of ingredients on their packaging, which can help us make healthy food choices. They begin to understand that despite convincing packaging and wonderful flavour, processed foods are often unhealthy choices for the lunchbox. Students watch a video that explains the effects of unhealthy or junk foods on their bodies. They examine two sample school lunch boxes to determine if healthy food choices have been made.

## Australian Curriculum content descriptions

### Science Understanding

#### Chemical sciences

Objects are made of materials that have observable properties ([ACSSU003](#))

#### Science as a Human Endeavour

Nature and development of science

Science involves exploring and observing the world using the senses ([ACSHE013](#))

### Science Inquiry Skills

#### Questioning and predicting

Respond to questions about familiar objects and events ([ACSI014](#))

#### Planning and conducting

Explore and make observations by using the senses ([ACSI011](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of the Foundation year, students describe the properties and behaviour of familiar objects. They suggest how the environment affects them and other living things.**

Students share observations of familiar objects and events.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))



## Background information

Scientists who work in the food industry include chemists, physicists, biologists, environmental geologists and health professionals. Job titles that students may recognise include dietitians, nutritionists, agricultural scientists, soil scientists, food engineers, dairy food scientists, cereal scientists, meat scientists and organic food scientists.

Diabetes is a chronic disease estimated to affect more than 1.7 million Australians. It is a progressive disease with serious complications that can lead to serious incapacity (resulting in poor quality of life) and reduced life expectancy. Whilst it can be determined by genetic factors, environmental (lifestyle) factors such as poor diet, obesity and insufficient physical exercise increase the risk of developing diabetes. Preventing or reducing the risk of diabetes through education on nutrition and healthy food choices is important.

## Materials and equipment

### Per class:

- computer, screen, Internet access
- food items/packages, enough for one per student with all labels where applicable. Must include a selection of natural foods (whole pieces/bags of fruit and vegetables, egg in an egg carton, empty milk containers, disposable plastic water bottles, tinned vegetables) and a selection of processed packaged foods or just the packaging. If possible include some commercially bagged vegetables eg carrots, onions, beans, sprouts, wrapped cucumber, cherry tomatoes as this will clearly show that natural foods don't usually need ingredients on their labels because you can see what they are made from.
- tray/s to carry and display food items
- 3 hoops
- labels for hoops – 'Made by people', 'Natural', 'Don't know'
- a few packets with misleading labels, which are designed to make people think they are healthy but the number/type of ingredients tells us otherwise.

### Per group:

- small plate of cut-up salad items eg carrot, celery, cucumber, lettuce, sprouts, beans
- small plate of cut-up fruit items

## Safety advice

Whilst the foods for consumption in this lesson are not usually associated with allergies, teachers must ensure that the foods selected take into consideration the individual needs of the students.

## Teaching sequence

### Lesson objective

In this lesson students recognise the differences between natural foods and those made by people. They identify the ingredients labels on packaging as a way of determining how healthy the food is. They consider why it is important for their function and growth to have healthy foods in their lunch box and at most other times.





## Introduction

Direct students to sit in a circle.

Explain to students that since all people need food, there are scientists who study food so that they can find out which foods are the healthiest for us. In this science lesson they are going to work like a food scientist and they will need to use all their senses to make observations.

Display a tray of various food and drink items, healthy and unhealthy.

Ask students to look at all the foods/food packages and suggest ideas for sorting the foods into groups. Prompt for a number of ideas, for example colour, size, taste, food categories (cereals, drinks, biscuits, fruit etc), healthy and unhealthy, foods we like or don't like. Explain that today we are going to sort the foods by how healthy they are.

Hold up a vegetable or fruit. Explain to the students that this is called a 'natural' or 'wholefood' because it has come straight from the farm or the vegetable garden. Nature made it and we usually can tell this by looking at it.

Hold up a packet of biscuits. Explain to students that people make biscuits and lots of things have been mixed together to make them. That is why you don't find biscuits growing on a tree or a vine. You don't know what is in them just by looking at them.

Lay the three hoops on the floor and place a label in each hoop. Distribute a food item (or packet) to each student. Invite groups of students to sort their items into natural foods and foods made by people, with the third hoop being for foods they aren't sure about. Then ask the group if they disagree with any placements and why. Discuss and also sort the ones in the 'don't know' hoop.

Explain that in the next activity students will be using their senses to explore one of the differences between natural foods and foods made by people and science tells us before we touch food we should have clean hands. Direct students to wash hands and sit at the tables/their desks on return.

Collect items for use later in the lesson.

## Core

1. Divide class into small groups and provide each group with a small plate of pieces of natural salad foods and ask them to use their senses to make observations about these foods.
2. Ask students to share their observations about the properties of these materials (eg different colours, comes from a plant, crispy, contain water, not sweet) emphasising that nature makes this food not people.
3. Now provide each group with a plate of fresh fruit pieces and ask them to use their senses to make observations about the properties of these foods. Compare the properties to those of the salad foods emphasising the main difference is an increase in sweetness but that nature makes them not people.
4. Project the PowerPoint presentation [Food detectives](#) and move to slide 2. Ask students to share ideas about the properties of these foods, especially who makes them and their taste. Support students to note that people, not nature, made these foods and they are sweeter/saltier than the salad/fruit items they have just tasted.
5. Ask these focus questions:
  - What do people put in foods and drinks like these to make them taste and look the way they do? (sugar/salt/colour)
  - What are these foods usually in when we buy them? (ie they are nearly always in packets/containers/bottles)
  - How could we find out what is actually in the foods and drinks made by people? (Look on the packaging)





6. Confirm that the things put into these foods are called the 'ingredients' and that these are always on the label. Display slide 3 showing various ingredients labels. Explain that when a food or drink is in a packet, bottle or container we should always be a food detective to see what the ingredients are and whether it is a good food for our bodies.
7. Explain to the students they are now going to be food detectives hunting for the ingredients on different foods and packets. Display slide 4 and explain that this is what a food label might look like. Display slides 5 through 7 to point out:
  - where to find the ingredients
  - that sugar, salt, flavour and oil are often in the list and science has taught us that we need to eat small amounts of these
  - that science has taught us that the more things in the list, the less healthy the food is likely to be.
8. Leave slide 7 on display and distribute a variety of food items/packets (previously sorted into the hoops) so that students can see both a natural food and a food made by people.
9. Allow time for students to explore and swap the foods/packets inviting students to try and count the number of ingredients.
10. Refocus students' attention and display two packets with words on the front that are designed to make us think they are healthy (eg packets with the words 'fruit', 'wholesome', 'healthy', 'nutritious' or pictures of sports stars or natural foods). Reinforce that even though these foods say they are healthy, if we look at them we know they are not found in nature and they often have lots of ingredients, which are not good for us.
11. Explain that you are now going to show them a video that explains why these foods should only be eaten as a treat – no more than one a day. Display slide 8 with the video — [Pyramid Power vs Junk Food Bandits Basketball Movie](#).
12. Briefly discuss the key messages of the video (ie unhealthy foods make you have less lasting energy, you feel tired after eating them, you can't concentrate) and point out that they also do bad things to your teeth and your blood (type 2 diabetes).

## Conclusion

Tell the students you are now going to show them a photo of two lunch boxes so they can show you how much they have learned about healthy eating. Display slide 9 and ask students to look closely and think about which lunch box is healthier and why. Invite them to share their ideas with the person beside them, then regroup and ask a few students to share their thinking.

## Lesson resources

### Digital resources

[Food detectives](#), PowerPoint presentation (3.8 MB)

[Pyramid Power v's Junk Food Bandits basketball movie](#), Nourish Interactive

### Useful links

[Nourish Interactive](#), nourishinteractive.com. Activities, games and quizzes on healthy food

[Toxic sugar](#), You Tube (18.01 min). ABC Catalyst program segment for teacher and parent information



# SUGAR — A SWEETENER TIPPING THE HEALTH SCALES

Sugar is the generalised name for sweet, short-chain, soluble carbohydrates, many of which are found in both natural and processed foods. Sugar is the main energy source for the brain and muscles.

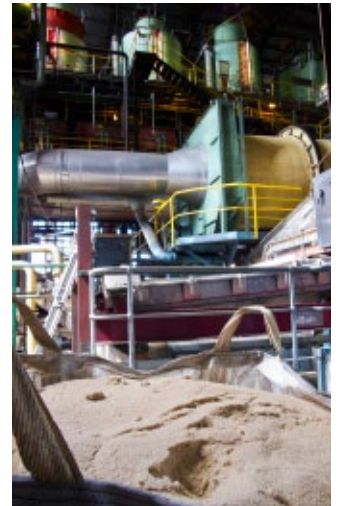
Sugar is added to processed foods for flavour, texture, bulk and as a preservative. However, some processed foods with large amounts of added sugar contain few other nutrients, making them energy dense but nutrient poor. This has become a modern-day health debate with mounting concern that the high amount of sugar in Western diets is behind a rise in obesity and diabetes, and declining dental health.

In March 2014, the World Health Organization (WHO) announced it was considering halving its recommended sugar consumption guidelines from less than 10 per cent of total energy intake per day to less than five per cent of total energy intake per day. This is equivalent to 25 grams (six teaspoons) of sugar per day for an average adult, and less for children. The WHO is concerned by how much of the sugar consumed is 'hidden' in 'non-sweet' processed foods. For example, one tablespoon of tomato sauce contains about four grams (one teaspoon) of sugar.

Sugar is a natural product, found in most plant tissue, but only present in sufficient quantities in sugar cane and sugar beet for economic extraction. In Australia, sugar is sourced from cane.

Extraction requires crushing the cane to release juice. This juice is evaporated until crystals of raw sugar (containing molasses) form and grow. It is a highly efficient manufacturing process: the fibre left after the cane is crushed fuels the sugar mill, while other waste is used to fertilise the cane fields. Molasses, the syrup residue that remains after raw sugar is made, is used in distilleries and livestock diets. Further refinement produces the familiar white sugar consumed in households and used in soft drinks and processed foods. This refining uses sulphur dioxide to 'bleach' the raw sugar crystals, then chemicals such as phosphorus acid, calcium hydroxide or carbon dioxide are introduced to absorb impurities before a final filtering to remove the molasses. White sugar is more than 99 per cent pure sucrose.

Australia produces both raw and refined sugar in an industry that comprises 3000 cane growers, 25 sugar mills and six shipping terminals. About 95 per cent is grown in Queensland, and the rest in northern New South Wales. More than 80 per cent is exported as bulk raw sugar, making Australia the world's second largest raw sugar exporter (behind Brazil).



## DID YOU KNOW?

- A 330-millilitre can of soft drink contains on average nine teaspoons of sugar.
- Before sugar was widely available, honey was used to sweeten food. Like sugar, honey is a carbohydrate.



Lesson plan: Year 1

# SUGAR DETECTIVES

## Introduction

The understanding that all living things need food is a founding scientific principle but is all food good for living things? In Australia, children (and adults) are enticed by an enormous array of processed foods that actually provide little nutritional value and instead fill us up with sugar, fat, salt, caffeine, flavours and colours. Consequently, preventable diseases like obesity and type 2 diabetes are escalating at a frightening rate.

This science lesson focuses on just one of the ingredients that is added to our foods – sugar. Some foods like fruit have sugar in them but they also have many other things that our bodies need, for example fibre, vitamins and minerals. They are also satisfying so we don't look for more food to eat. In addition, the sugar is of a type and dilution that our bodies can digest without getting a sugar overload. Foods made by people (processed foods) tend to have larger quantities of sugar with less nutritional value. Soft drinks, cakes, biscuits, juices, cordial and confectionary hit our systems with much more sugar than is good for us and in a short period.

In this lesson, students identify the amount of sugar in both natural and processed foods and observe packaging in order to locate information on how healthy the food is and how 'healthy' pictures and words on packaging can be misleading.

## Australian Curriculum content descriptions

### Science as a Human Endeavour

#### Nature and development of science

Science involves asking questions about, and describing changes in, objects and events ([ACSH021](#))

#### Use and influence of science

People use science in their daily lives, including when caring for their environment and living things ([ACSH022](#))

### Science Inquiry Skills

#### Questioning and predicting

Respond to and pose questions, and make predictions about familiar objects and events ([ACSI024](#))

#### Planning and conducting

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ([ACSI025](#))

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ([ACSI026](#))

#### Processing and analysing data and information

Through discussion, compare observations with predictions ([ACSI0212](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))



## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 1, students describe objects** and events **that they encounter in their everyday lives, and the effects of interacting** with materials and **objects**. They identify a range of habitats. They describe changes to things in their local environment and suggest how science helps people care for environments.

**Students make predictions, and investigate everyday phenomena.** They follow instructions to record and sort their observations and share their observations with others.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](http://acara.edu.au))

## Background information

For information regarding the amounts of sugar in foods and the need to limit sugar intake watch the ABC Catalyst program [Toxic Sugar](#).

## Materials and equipment

### Per class:

- computer, screen, internet access
- 2 large cards, one question on each – 'Do you know how to pick healthy foods from unhealthy ones, especially sugary foods?' 'Why do we need to choose healthy foods low in sugar?'
- 1 orange
- 1 carrot
- 1 bottle of water (commercially packaged)
- 1 bottle or tetra pack of juice
- 1 snack bar in packaging eg muesli, energy, health type
- 2 empty, clear drinking glasses
- sharp knife
- cutting board
- hand juicer
- approx. 500g of sugar (white is best)
- teaspoon

### Per group:

- cardboard box with one food package/item per student. Try to choose items that students are likely to be familiar with, for example, cereals, snack bars, biscuits, yoghurt, flavoured milk, juice, chocolate, confectionary, energy drinks, particularly those that have misleading words like 'nutritious', 'fruit', 'good for you' and images of sports people)
- counters or other uniform sets of small items (eg MAB blocks, pasta, beads, matchsticks) to represent spoons of sugar (one item equals one teaspoon of sugar). At least 30 pieces per student. Groups do not need to have the same type of material. Alternately, sand could be used, in which case each student would need a teaspoon.
- tray/plate to hold counters
- plastic cups – 1 per student
- 1 clear, tall glass containing 20 teaspoons of sugar



## Safety advice

Ensure sharp knife is stored safely immediately after use.

## Teaching sequence

### Lesson objective

In this lesson, students identify the sugar properties of different foods. They observe packaging to identify where to find information about the healthiness of a food and how words and pictures on the front of packaging can be misleading. They represent the amount of sugar found in some of the foods they may eat in a day and learn why high sugar foods should be eaten in small quantities.

### Introduction

Explain that this week is National Science Week and whilst every week is a great week for learning science, this week helps us to remember how important science is for solving problems in the world.

Tell students that Science Week this year is about food and science. We know that all living things need food and water and if they don't get these things then that is one problem but another problem is the type of foods we are eating, especially ones that have a lot of sugar, and this is the problem that we are looking at in science today.

Display the two question cards to students and tell them that in this science lesson they are going to use science to answer these questions.

Ask students to imagine they are going on a bush walk and they can use their knowledge of healthy foods to choose two foods to take with them. Display the orange, carrot, bottle of water, the juice and the snack/ health/ energy bar. Explain that in this science lesson they will do two activities to find out which are the healthier foods to choose.

## Core

### Activity 1

1. Hold up the orange and ask students to raise their hands if they think the orange would be a healthy choice and why. (it's fruit, my mum says, I just know it).
2. Ask students how was the orange made – did people make the orange or did nature make it and people just pick it? Explain that we call the orange a natural or wholefood because nature, not people, made it.
3. Cut the orange in half and display the pieces. Ask students to use their observation skills to describe the properties of the orange (round, orange colour, has a skin, has seeds, juicy, sweet).
4. Display the juicer and ask students to identify its purpose, confirming that the juicer squeezes the juice from the orange and separates it from the skin and seeds so we end up with just juice. Model squeezing half the orange for students to see.
5. Display a glass and ask students to predict how full the glass will be with the juice from the orange. Pour the juice into the glass and holding it up ask the students the following questions:
  - What do you observe? (a very small amount from half an orange)
  - How many oranges do you think we would have to squeeze to make just one glass of orange juice? (approximately four medium oranges)
  - Do we normally eat four oranges at one time?
  - How do you think you would feel after eating four oranges in one go compared to a glass of juice (full compared to juice)





6. Hold up the juiced half and point to the left over flesh parts. Explain that when we juice an orange, we leave behind lots of good things like fibre, vitamins and minerals. All we take is the juice so we waste all these other parts.
7. Hold up the glass of juice, moving it gently and ask students the following questions:
  - What do you think is in juice? (water and tiny bits of orange)
  - How does juice taste? (sweet)
  - What usually makes things sweet? (sugar)
8. Explain that now comes the scary bit... how much sugar do you think is in one orange? Tell them there are about 5 teaspoons of sugar in one orange and ask a student to measure out 5 teaspoons of sugar into an empty glass for students to see how much sugar this is. Explain that this sugar is a natural type and not as bad as the added sugar in other foods.
9. Explain that because the juice of an orange holds a lot of the sugar and we know that there are four oranges in one glass of juice, there are more spoons of sugar in a glass of juice. Depending on the brand, there can be around 7–10 teaspoons of sugar in a glass of juice because the factories that make juice for the supermarket often add extra sugar. Ask a student to add five more spoons of sugar to the glass and imagine eating it.
10. Summarise by saying that science tells us that fruit juice is actually not a healthy food choice. Even though an orange has sugar in it we are better to eat the orange because it is made by nature, it has less sugar than bottled juice, it has lots of other healthy parts and it fills us up more so we don't go looking for unhealthy foods to eat.
11. Tell students that they are now going to continue being sugar detectives with some other foods, but before they do they are going to have a drink of something that has no sugar and we need to have to stay alive. Ask them what they think it is (water) and tell them when they have their drink try to imagine what it would be like if there wasn't water to drink.
12. Regroup at desks.

## Activity 2

1. Divide the class into groups and explain that each group will be given a box with some different packages inside.
2. Instruct each student to choose one item from the box and discuss with the other group members if it is a healthy food or not. Ask students to suggest reasons why they think some of the foods might be healthy.
3. Hold up an example packet that has some misleading words/pictures on it like 'nutritious', 'healthy', 'fruit', 'energy', 'good for sports people'. Explain that sometimes these pictures and words are trying to trick us into buying the food and the only way we can really find out about the food is to look for a special label on the packet.
4. Ask students to look on any packet and see if they can find the information label that tells them about what is in each of the foods — the ingredients. Allow time for exploring and then display the PowerPoint [Sugar detectives](#). Go to slide 2.
5. Ask students if they can find a label like this on their packets and explain that this type of label tells us the ingredients that have been used to make the food. Point to ingredients. Explain that the label also tells us how healthy the food is. For example, it tells us how much sugar there is in the food. Tell students they are now going to use some of these labels to see how much sugar is actually in their food.
6. Distribute a plate/tray of selected counters and the plastic cups to each group.





7. Explain to students that because sugar is sticky and will attract ants into the classroom, they are going to pretend that each counter is one teaspoon of sugar. Tell them you are going to name a food and tell them how many teaspoons of sugar is one serve of this food. Each time they are to take the number of counters to match the number of teaspoons of sugar and put it into the cup.
8. Using the [Sugar amounts in common foods table](#) at the end of this lesson, select some common foods and tell students the amount of sugar each has, preferably starting with types that were identified as healthy in the above package activity. Start with a couple of breakfast foods, then some lunch foods, and a snack food and sweet drink. Include some healthy foods too, like carrot sticks, a boiled egg and a salad sandwich. When ready (or cup is full), ask students to try and count how many spoons of sugar they have 'eaten'.
9. Invite students to share how much sugar they have put into their cups and then tell them you have something to show them. Hold up a glass with 20 spoons of sugar in it and ask them how they think they would feel if they tried to eat all this sugar. Tell them that another really bad thing about eating this much sugar is that it tricks your brain into thinking you are still hungry and wanting more sweet food.
10. Explain that now you are going to tell them something really, really amazing... they should only be eating about 3 teaspoons of added sugar a day. Added sugar is found in many packaged foods that people make.
11. Tell students to put the counters back on the tray so they can do another 'sugar in food' activity.
12. Ask students to think of a drink that has no sugar (water). This means no spoons of sugar and because our body loves water we can have lots of drinks of water in a day.
13. Invite students to try and recall other no or low sugar foods (use [Sugar amounts in common foods table](#) to help prompt) and add the amount of sugar to their cup. Ask them if they can see why they should think carefully about what they eat and to really think carefully about how much sweet food they choose to eat.
14. Pack up packages and equipment.

## Conclusion

Explain to students that now they know how much sugar is in food, they are going to watch a video that explains what happens when you eat unhealthy food. Show students [Pyramid Power vs Junk Food Bandits basketball movie](#).

Summarise by recapping the key messages from the video about unhealthy foods (poor concentration, energy at first but not lasting, can make you feel uptight and unwell). Refer back to the two questions displayed at the beginning of the lesson and re-read them asking if they think they know the answers a little better. Show the items displayed for the bush walk at the start of the lesson (remaining orange half, water, juice, carrot and snack bar) and confirm that now we know that the healthiest choices are the orange or carrot and the water. Explain that they need to use what science has taught them to ensure they make healthy food choices.



## Lesson resources

### Digital resources

[Sugar Detectives](#), PowerPoint (1 MB)

[Sugar amounts in common foods table](#), page 23

[Pyramid Power v's Junk Food Bandits Basketball movie](#), Nourish Interactive

### Useful links

[A teaspoon guide to Australian breakfast cereals](#), How much sugar? Information for teachers (PDF, 677 KB)

[How much sugar is in your food?](#) Medical News Today. Article (last updated 6/1/14)

[How much sugar is in your kid's food?](#) Your Kid's Table. Information for teachers

[Nourish Interactive](#), nourishinteractive.com. Activities, games and quizzes on healthy food

[Rethink your drink – Be sugar savvy](#), SFGov. Activities

[Toxic sugar](#), You Tube (18.01 min). ABC Catalyst program segment for teacher and parent information

[Would you eat a stack of 16 sugar cubes?](#) Sugar Stacks. Comparing sugar quantities in different foods



## SUGAR AMOUNTS IN COMMON FOODS

Please note: this is sugar content only. Food choices should also take into account salt, fat and additives (colours/ flavour). Whole (natural) foods may have sugar but will also contain fibre, protein, vitamins and minerals. Amounts will vary with brand. Check individual food labels.

Food	Grams of sugar per serving	Teaspoons of sugar per serving 1 tsp = 4 grams	Food	Grams of sugar per serving	Teaspoons of sugar per serving 1 tsp = 4 grams
<b>Breakfast type</b>					
White bread (2 slices)	1.8	½	2 Weetbix (without sugar added)	2	½
Multigrain bread (2 slices)	1.3	¼	Nutrigrain (45 g bowl)	13	3
Toppings (20 g)			Crunchy Nut (45g bowl)	13	3
Vegemite	<1	0	Rice Bubbles (45g bowl)	4	1
Peanut paste	2	½	Coco Pops (45g bowl)	16	4
Jam	10	2 ½	Fruit Loops (45g bowl)	20	5
Honey	16	4	Sultana Bran (45 g bowl)	14	3 ½
Butter	<1	0	Breakfast bars (100 g bar)	About 30	7 ½
Margarine	<1	0	Milk (½ cup)	6	1 ½
Eggs	0	0	Juice (250 ml glass)	28	7
Cornflakes (45 g bowl)	4	1			
<b>Snacks</b>					
Carrot sticks	0	0	Dried apples (25g)	15	4
Cucumber sticks	0	0	Dried apricots (25g)	13	3
Cherry tomatoes 3	0.5	½	Yoghurt (1 snack tub)	16	4
Green beans	0	0	Arrowroot biscuits, plain (2)	4	1
Strawberries (3-4)	4	1	Sweet biscuits, choc chip (2)	16	4
Banana (small)	12	3	Biscuits, cream filling (2)	20	5
Apple (med)	20	5	Shortbread, plain (2)	8	2
Orange (med)	20	5	1 low-fat muffin (commercial)	18	4 ½
Granola bar, fruit filled, non fat (per 100g)	26	6 ½	1 donut	21	5
Choc muesli bar	23	6	Biscuit cheese dipper snack		
Fruit sticks 1	16	4	1 cheese stick	<1	
Nuts (plain, 50g)	2	½	4 savoury crackers	4	1
Sultanas	16	4			
<b>Lunch (in addition to above)</b>					
Cheese sandwich	<1	0	Honey sandwich	16	4
Vegemite sandwich	0	0	Jam sandwich	10	2 ½
Peanut paste sandwich	<1	0	Avocado	<1	0
<b>Drinks (330 ml can)</b>					
Coke/cola	39	10	Hot chocolate	18	4 ½
Orange soft drink	12	3	Energy drinks (e.g. Red Bull)	30	7 ½
Lemon soft drink	41	10 ½	Vitamin water	13	4
Lemonade	24	6	Fruit smoothie	14	3 ½
Flavoured milk (240ml)	29	7	Chocolate milk shake	62	15
<b>Confectionary</b>					
Starburst packet (45g)	22	5 ½	Snickers bar (57g)	28	7
M&Ms (45 g)	23	5 ¾	Marshmallows (50 g)	28	7
Milky Way bar (58 g)	34	8 ½	Chocolate (50g)	24	6

Information obtained from food labels of various brands and websites including:

[Sugar stacks – How much sugar is in that?](http://www.sugarstacks.com) www.sugarstacks.com (Accessed April 2014)

[‘How much sugar is in your food?’](#) Medical New Today website (last updated 6 January 2014)

[‘How much sugar is in your kid’s food?’](#) Your kid’s table website (8 October 2012)

[A teaspoon guide to Australian breakfast cereals](#), How much sugar? website (2010)



# HEALTHY FOOD STARTS WITH HEALTHY SOIL

Of the more than 90 known natural elements, 30 mineral nutrients are the basis of the biochemistry that supports life. These nutrients are obtained from the soils that grow the plants and animals that we consume for food.

Soil biology is central to sustainable agriculture and food production. This is why there is considerable scientific input into better understanding soils and the microbes, micro fauna and mycorrhizal fungi that convert these minerals into soluble forms for plant roots to absorb.

Soil nutrients are a finite resource. They are lost when plants are harvested or grasses are eaten by livestock. So unless well managed, soils over time can become depleted: the microbial life dies, the physical structure of the soil collapses (along with its capacity to hold moisture) and we see the onset of erosion – and in many examples through history, famine.

Agricultural soils are today under pressure as farmers are forced to produce higher yields from diminishing land area. In many countries, including Australia, the most fertile soils are fast disappearing beneath urban sprawl.

To make soils productive, increasingly high levels of artificial fertilisers (heavy in nitrogen, phosphorus and potassium) along with herbicides and pesticides are needed to deal with a system knocked out of balance. Many of these chemicals are toxic to soil microorganisms. This causes further deterioration in soil quality, and in the quality of the food grown because many elements needed by our bodies are not found in artificial fertilisers – they are only provided by microbial symbionts working in the soil. Selenium, which is required for the enzymes that attack cancer cells, is one example.

Agriculture, however, is responding. Australia's grains industry, for example, annually invests several millions of dollars in soil science and new farming systems to restore soils to a more natural equilibrium while still lifting productivity. In less than two decades, ploughing has almost disappeared as a practice. Crop stubble is now left on the surface to decompose into humus to support microbial life. New herbicides are biodegradable and farmers are re-establishing native bushland for beneficial insects that can control crop pests naturally.

Modern farming systems must manage four primary functions: carbon transformations (stubble decomposition); nutrient cycles (keeping nutrient levels replenished and balanced); soil structure (friable, not compacted); and the regulation of pests and diseases using, as far as possible, biological controls. These are the keys to healthy soils delivering healthy food.



## DID YOU KNOW?

- In a healthy ecosystem, there is more life and more diversity below ground than above.
- Earthworms can turn over the top 15 centimetres of soil every 10 to 20 years in areas where they are active.
- Biological, physical and chemical processes all contribute to soil health, yet understanding these interactions is a comparatively new field of science.





Lesson plan: Year 2

# HEALTHY SOIL, HEALTHY LIVING

## Introduction

We tend to take the ground we walk on for granted and yet we are dependent on it for our food. Most students (and adults) will be surprised to learn that only 1/32 of the Earth's surface is actually suitable for food production and this is one reason why many people do not get enough food to eat. We also have most of our cities and people living in the same places where the good soil is and, of course, the world's population is growing at one and a half million people per week.

This lesson aims to teach year 2 students that science helps us to understand and look after the soil as one of Earth's very important resources. After using a model to illustrate that only a small part of our planet can grow food, students begin to learn what healthy soil looks like and what it can grow. Students go on a field walk to observe features of healthy and unhealthy soil. They consider why only a small part of the school grounds are used to grow food and consider an alternate way to create a healthy soil environment for growing vegetables.

This lesson works towards understanding the Australian Curriculum cross-curriculum priority of sustainability. It contributes to the development of knowledge, skills, values and world views necessary for students to act in ways that contribute to more sustainable patterns of living.

## Australian Curriculum content descriptions

### Science Understanding

#### Earth and space sciences

Earth's resources, including water, are used in a variety of ways ([ACSSU032](#))

### Science as a Human Endeavour

#### Use and influence of science

People use science in their daily lives, including when caring for their environment and living things ([ACSHE035](#))

### Science Inquiry Skills

#### Planning and conducting

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ([AC SIS038](#))

#### Communicating

Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play ([AC SIS042](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#)).





## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 2, students** describe changes to objects, materials and living things. They **identify that certain** materials and **resources have different uses and describe examples of where science is used in people's daily lives**.

**Students pose questions about their experiences and predict outcomes of investigations. They** use informal measurements to **make and compare observations**. **They** follow instructions to record and represent their observations and **communicate their ideas to others**.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](http://acara.edu.au)).

## Background information

World population is increasing at around 82 million people per year. Whilst it is difficult for year 2 students to comprehend the scale of this increase, many are impressed by the word 'million'. Alternately, telling students if they counted by twos every second from the moment they had breakfast to the moment they have dinner (say 7 am to 6 pm) and did nothing else all day but count, they would only count about one third of how many extra people there are on Earth every day (224, 657 more people per day).

## Materials and equipment

### Per class:

- computer, screen, Internet access
- large apple
- sharp knife for teacher
- cutting board
- gardening fork

### Per student:

- 1 ball modelling dough (approx. 6 cm diameter)
- plastic knife
- pair of gardening or sterile gloves

## Safety advice

Knives – teachers need to assess the risks of using plastic knives depending on their students. The sharp knife should remain in the teacher's possession during its use then removed from student access.

Sun safety – as with all outdoor activities sun safety policies must be followed.

Observing soil – risks include insect bites and exposure to Legionella bacteria. Provide gloves and remind students not to breathe in the soil. Wash hands with soap on finishing observation.

## Teaching sequence

### Lesson objective

In this lesson, students understand that only a small area of the Earth's surface is suitable for growing foods and that science can help us keep this area healthy to help feed the world's people.





## Introduction

Explain that this week is National Science Week and whilst every week is a great week for learning science, this week helps us to remember how important science is for solving problems in our world.

Tell students that the focus of Science Week this year is feeding our world through science. Ask students how they think science can help feed people. Share ideas to ascertain prior knowledge.

Direct students to be seated at desks in view of whiteboard/screen.

## Core

1. Display the PowerPoint presentation, [Healthy soil, healthy living](#). Go to slide 2 and ask students where does food come from? Scaffold the discussion to identify that food originally comes from plants and animals, though some is changed a lot by people in factories (eg soft drink, some cereals, biscuits, lollies). If students seem unconvinced, ask them to name any food and you (or a class member) will tell them the plant or animal it comes from. This can be checked later in a web search if need be.
2. State that because all our food originally comes from plants and animals, there are many different scientists who study plants and animals because sick plants and animals don't give much food. (Slide 3)
3. Ask students to share ideas about what scientists know are the needs of plants, clicking through slide 4 to reveal plant needs. Summarise by stating that because scientists know these needs, that is what they study to help plants grow the best they can.
4. Explain that today's science lesson is going to focus on just one of these needs and that is the soil that plants (and animals) depend on. Scientists know that if the soil is healthy, the plants will be healthy and produce good food. (Slide 5)
5. Display slide 6, identifying planet Earth. Pose the questions:
  - Where can we grow food on our planet?
  - How much usable soil is there on Earth?
6. Explain that we are going to pretend that Earth is an apple and that scientists often use smaller objects as models for bigger things. Instead of an apple, explain that they will use a ball of modelling dough. Distribute the dough and plastic knives explaining the safety expectations. (Slide 7)
7. Click through slides 8 to 11 and cut your apple while students cut their dough to reveal the diminishing amount of space that is available for food growing.
  - Slice an apple into quarters. Set aside three of the quarters, as they represent water on the Earth's surface.
  - Cut the remaining quarter in half. Set aside one of the halves as uninhabited deserts, swamps and the Arctic and Antarctic areas.
  - Divide the remaining piece into quarters. Set aside three of the pieces for land that is too rocky, wet, hot or poor for crop production.
  - The remaining piece is 1/32nd of the original apple. Peel this section. The peel represents the thin layer of soil that is available for producing all of the world's food.
8. Explain that this little space is also where most of the world's people live. (Slide 12)
9. Tell students that there are also one and a half million more people to feed every week so we need to be able to grow a lot more food in the same amount of soil. Show slide to try to give some perspective to this. (Slide 13)
10. Re-emphasise the importance of this small amount of our planet. (Slide 14)



11. Explain to the students they are going to watch a video that gives some important tips on how we can get the most out of that little part of our Earth that makes our food. (Slide 15) Display the video [The life in dirt](#) asking students to look for things that help to make soil healthy.
12. Explain to students that when a scientist is trying to study the health of soil they usually go out to look at the soil. This is called going out in the field. Tell them they are going to look at soil in two different places in the school. Identify these (eg the vegetable garden/rainforest garden and the soccer field/the eating area) and ask students to predict which soil they think will be the healthiest.
13. Explain that because they are touching the soil it is best to wear gloves in case of spiders, ants etc and as scientists they are observing and taking care not to harm anything. They also need to take care not to breathe in the soil as there are tiny bacteria in soil that can make people sick.
14. Move students to the healthy soil area (ideally mulched) first to reinforce things that are likely to be missing in the unhealthy area. Encourage students to observe with their eyes first then:
  - if the soil is mulched, discuss why mulching helps soil health (protects from wind, keeps soil, worms and roots dark, warm and moist)
  - tell students to move a little mulch away and to try and push one finger into the soil. Observe how easily it goes in
  - ask students to pick up a small handful of soil and observe for bits of compost or creatures and the colour and features of the soil grains
  - try and squeeze a little of the soil into a ball to see if it is moist
  - gently break up the squashed soil, replace and return mulch cover
  - ask students if they consider this soil to be as healthy as they predicted.
15. Move students to an unhealthy soil area and ask them to suggest why you have brought them to this spot. Repeat the observation process above for the unhealthy soil. Discuss why it might be like this and whether it would grow food. If soil cannot be 'dug up' use the garden fork to reveal what it is like underneath.
16. Return to classroom, washing hands with soap on route.

## Conclusion

Ask students why only a small part of the school is set up to grow food? Discuss how a school has to have lots of space for many different activities and recall how the little piece of the Earth shown by the apple model also had to have space for lots of people and buildings, as well as growing food. Explain that this means we need to use our soil and space wisely. Ask who has a vegetable garden at home, and if not, is space a reason? Explain that vegetables grow really well in pots and they are really delicious when they are picked fresh. Display the video [Vegetable gardens](#) to show how students could do this themselves. (Slide 16)

Conclude by inviting a few students to sum up what they have learned about in this lesson for National Science Week.

## Lesson resources

### Digital resources

[Healthy soil, healthy living](#), PowerPoint presentation (3.4 MB)

[The life in dirt](#), ABC Splash (5.19 min)

[Vegetable gardens](#), ABC Splash (5.18 min)

### Useful links

[Designing a school garden](#), ABC Splash. Video (4.32 min)

[Explore an awesome school garden](#), ABC Splash. Video (4.36 min)

L3 [Create a soil environment](#), NDLRN. Learning object



# CHOCOLATE — FOOD OF THE GODS

Mankind gets its chocolate fix – exceeding 3.6 million tonnes of cocoa beans a year – from the seeds of an ancient crop that grows in the shaded understorey of rainforests. Under this protective canopy, a tropical tree, *Theobroma cacao*, derived from Mayan for ‘food of the Gods’, has been supplying our insatiable appetite for the rich flavour of chocolate for more than two millennia.

The birthplace of chocolate is thought to be south-east Mexico, where the Olmec people were the first recorded humans to harvest wild cocoa seeds to make a much-treasured medicinal beverage. Cocoa cultivation expanded into the rainforests of Central and South America, and over time to South and South-East Asia, West Africa and the Pacific.

The Swiss development of milk chocolate in the early 1800s triggered a meteoric rise in global chocolate consumption, and cocoa beans are today the world’s seventh most traded commodity. Average per-person consumption in Australia, Europe and North America is six kilograms a year.

Contributing to this demand is recent research showing regular consumption of dark chocolate, which contains high levels of raw cacao, provides antioxidants and beneficial gut bacteria that provide several health benefits, including improved vascular function and increased insulin sensitivity, which is important for the body’s regulation of glucose delivery into cells.

However, chocolate production – centred almost entirely in developing countries – faces a range of environmental, economic and social challenges. Sustainable supply pressures include climate change, deforestation, political and economic



instability, more profitable cropping alternatives as tropical agriculture diversifies, ageing cacao plantations, declining soil fertility, pressure from pests and diseases, and a limited genetic base for breeding improved cacao varieties.

One bid to counter this is the birth of an Australian cocoa industry in the Daintree region of Far North Queensland. The fledgling Australian cocoa industry is based on a cooperative family farming model rather than a corporate structure. The Australian cocoa cultivation also follows traditional methods: ripe cocoa pods are harvested by hand and pickers manually remove 30 to 50 seeds from each pod. The wet, bitter seeds are fermented for two to eight days before being dried and roasted, and finally cracked and winnowed into smaller pieces, called cocoa nibs. These are ground to a powder for manufacturing chocolate.

Different types of chocolate, such as dark, milk and white, are created by varying the mixture of cocoa with sugar and other additives such as milk powder.



## DID YOU KNOW?

■ Raw cacao is made by cold-pressing unroasted cocoa beans. The process keeps the living enzymes in the cocoa and removes the fat (cacao butter). This makes the ‘healthy’ dark chocolate. Cocoa powder is raw cacao that has been roasted at high temperatures. Roasting reduces the enzyme content and lowers the beans’ nutritional value.

■ Cocoa is a major source of income for more than 40 million smallholder farmers in developing countries.



Lesson plan: Year 3

# WHICH MELTS THE FASTEST? WHITE, BROWN OR DARK CHOCOLATE?

## Introduction

In this lesson students investigate how liquids and solids respond when heat is added or taken away. They do this by observing what happens to solids such as ice, butter and chocolate when heat is added. Students participate in investigations that involve applying heat to a solid. Students apply this knowledge to plan and conduct an investigation to determine which type of chocolate melts the fastest: white, milk or dark. They make predictions and observations, record data and report on their findings. Students address how knowledge of solids, liquids and the behaviour of heat can help them in their everyday lives.

## Australian Curriculum content descriptions

### Science Understanding

#### Chemical Sciences

A change of state between a solid and a liquid can be caused by adding or removing heat ([ACSSU046](#))

### Science as a Human Endeavour

#### Nature and development of science

Science involves making predictions and describing patterns and relationships ([ACSHE061](#))

Science knowledge helps people to understand the effects of their actions ([ACSHE062](#))

### Science Inquiry Skills

#### Questioning and predicting

With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge ([AC SIS064](#))

#### Planning and conducting

Suggest ways to plan and conduct investigations to find answers to questions ([AC SIS065](#))

Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate ([AC SIS066](#))

#### Processing and analysing data and information

Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ([AC SIS068](#))

#### Communicating

Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports ([AC SIS071](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))



## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 3, students use their understanding of the movement of the Earth, materials and the behaviour of heat to suggest explanations for everyday observations.** They describe features common to living things. **They describe how they can use science investigations to respond to questions and identify where people use science knowledge in their lives.**

**Students use their experiences to pose questions and predict the outcomes of investigations. They make formal measurements and follow procedures to collect and present observations in a way that helps to answer the investigation questions. Students suggest possible reasons for their findings. They describe how safety and fairness were considered in their investigations. They use diagrams and other representations to communicate their ideas.**

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#)).

## Background information

All things are made of matter and matter is all around us. Matter can be categorised as a solid, liquid, gas or plasma. This is called its 'state'. All states of matter have properties and behave in particular ways. Liquids flow and take the shape of the container they are in. Similarly, gases also flow and move to fill a space. For example, gas will move from a container to completely fill a room when released from that container. Solids have a firm, stable shape and a fixed volume. Solids also maintain their shape and can be of any size or shape. Solids do not need to be hard. For example, a cuddly toy is a solid as it has a fixed, stable shape but it is not hard. Liquids, solids and gases can be affected by heat. Heat can be added to or taken away from liquids and solids and this can result in a change in their state. For example, water is a liquid and when heat is taken away, changes state to become a solid (ice). If heat is added to water, it becomes a gas (steam/water vapour). Sand is an interesting solid as it flows and can fill the shape of a container. Sand is still a solid, as each grain of sand has the properties of a solid, though very small.

## Materials and equipment

### Per class:

- assortment of liquids – a mixture of thin and thick liquids such as water, milk, oil and honey.
- assortment of solid shapes – a mixture of soft and hard solids such as glass, cloth, toy and sand.
- easily melted solids such as butter or ice-cream
- ice cubes
- paper plates
- plastic cups
- stopwatch
- teaspoons

### Per group:

### Chocolate investigation – Method 1

- 1 piece of white, milk (brown) and dark chocolate
- 3 plastic re-sealable bags
- stopwatch





## Chocolate investigation – Method 2

- 1 piece of white, milk (brown) and dark chocolate
- 3 paper plates
- stopwatch

## Safety advice

### Safety advice for working outdoors:

- Conduct appropriate risk management prior to implementing outdoor activities.
- Consult the sun safety and outdoor activity guidelines for your school or organisation prior to implementing outdoor activities.
- Ensure students wear sun protective hat, clothing and sunscreen.
- Monitor students whilst carrying out explorations for living things – remind students not to taste or ingest materials.

### Safety advice for working with hot water:

- Conduct appropriate risk management prior to implementing activities involving heat or hot water.
- Consult the activity risk management guidelines for your school or organisation prior to implementing activities involving heat or hot water.
- All water must be tested prior to student use – ensure it is tested with a thermometer and is less than 45°C.
- Only teachers or supervising adults should handle water above 45°C.
- Ensure students wear personal protective equipment during investigations.

## Teaching sequence

### Lesson objective

In this lesson students explore solids and liquids and how a change of state can occur when heat is added or taken away. Students observe the behaviour of solids and liquids and conduct an investigation to answer the question: Which melts the fastest: white, milk (brown) or dark chocolate?

### Introduction

Show students a collection of liquids and solid objects and ask them to sort the objects into categories and to explain their reasoning. Identify that all things are made of matter and that matter is everything around them.

Explain that:

- matter can either be a liquid, solid or gas and that this is called its 'state'.
- liquids and solids behave in particular ways.
- liquids flow and take the shape of the container they are in.
- solids have a firm and stable shape and can maintain that shape.
- liquids and solids can be affected by heat.
- heat can be added to or taken away from liquids and solids to change their state.

Clarify that this means that liquids can become solids and solids can become liquids according to whether heat is added or taken away. (Note that not all solids can become liquids, however, they can be made smaller). Inform students that these changes are called 'physical changes'.

Students complete the learning object [Changing state](#) that demonstrates the change of state from a solid to a liquid by adding heat.





## Core

1. Show students an ice-cube on a plate and ask them to indicate if ice is a solid or a liquid. Wait for the ice to melt into a liquid. Discuss what happened to the ice.
2. Ask students the question 'Why do things melt?' and collate their answers. Confirm with students that things melt because they have had heat added to them. Ask students to identify familiar items/objects that melt such as butter or ice-cream.
3. Ask students to list factors they think contribute to things melting, such as being placed in direct sunlight or being heated on a stove and collate their answers.
4. Discuss with students the safety implications of working with heat and how to minimise the occurrence of injuries.
5. Conduct this activity that demonstrates solids changing state to liquids when heat is added to them:
  - Supply students with a spoonful of a solid that melts easily/quickly (such as butter or ice-cream) on a plate.
  - Have students place the plate outdoors, preferably in a sunny area.
  - Ask students to measure the time it takes for the solid to melt, using a stopwatch.
  - Ensure students record their observations and data.
  - Share findings following the activity.
  - Ask students to explain why the solid melted.
6. Discuss with students that scientists use investigations to help them answer questions and solve problems.
7. Inform students that they are going to act like scientists and conduct an investigation to help them answer the question: 'Which chocolate melts the fastest: white, milk (brown) or dark?' Confirm that chocolate is a usually a solid but can be changed to a liquid when heat is added.
8. Ask students to identify things that they know about chocolate and collate their answers. (This could include type of chocolate or ingredients such as milk, sugar and cocoa). Identify that chocolate originates from a plant and is processed to become the product we are familiar with.
9. Inform students that they are going to conduct an investigation where they will be adding heat to different types of solid chocolate to determine how fast each type of chocolate melts.
  - Provide students with the worksheet, [Melting chocolate investigation](#) at the end of this lesson.
  - Explain to students that prior to conducting an investigation, scientists make predictions about that they think will happen during the investigation. Ask students to make a prediction about which chocolate they think will melt the fastest and to write their prediction on the worksheet.
  - Divide students into groups and hand out materials and equipment to each group.
  - Ask students to identify ways that they could add heat to chocolate to make it melt, without the use of a stove or flame.
  - Inform students they have the choice of two methods to use to carry out their investigation. (Refer them to the worksheet)
  - Have each group determine the method of adding heat they will use.
  - Inform students they need to follow the instructions on the worksheet to carry out the investigation.
  - Assist groups to carry out the investigation.
  - Remind students to record their observations and data on the worksheet.
  - Photograph student progress for collation and monitoring purposes.
  - Ask students to share their results with the class and collate their findings.
  - Have students identify which chocolate melts the fastest.



**10.** Ask students to suggest reasons for their results. Focus questions could include:

- Why do you think the XXX chocolate melted the fastest?
- What factors do you think contributed to it melting quicker?
- What do you think the chocolate contains that might have made it melt faster than the others?

**11.** Discuss how students might turn the liquid chocolate back into a solid. (Confirm that this would involve taking heat away or cooling the chocolate.)

**Idea for further learning** – Conduct an investigation on taking heat away such as cooling/setting jelly. See [Science Web Year 3-4 Transfer of heat - lesson 5](#).

## Conclusion

Remind students that science helps us answer questions and solve problems.

Discuss with students how having knowledge about solids, liquids and the physical changes caused by adding or taking away heat can help them in their everyday lives.

Ask students to make suggestions about ways they could use this scientific knowledge every day.

## Lesson resources

### Digital resources

[Changing state](#), BBC Schools Science clips

### Worksheets

[Melting chocolate investigation](#) (see pages 35-36)

### Useful links

[About chocolate](#), Cadbury Chocolate Australia. Information on all things to do with chocolate production

[How to read a thermometer](#), NSTA. Technique sheet for teachers (PDF, 16 KB)

[Matter: states of matter](#), Chem4kids. Information for students

[SPECTRA Awards](#) – Energy card, Australian Science Teachers Association. For similar activities on energy and heat transfer, try out some of the cool activities on the ASTA SPECTRA Energy card. Students will earn stars with each activity completed to earn them awards from the Australian Science Teachers Association.

[Transfer of heat](#), Science Web. Unit of five lessons for years 3-4



## Year 3 | WHICH CHOCOLATE MELTS THE FASTEST: WHITE, MILK OR DARK?

Name: ..... Class: ..... Date: .....

# Melting chocolate investigation

During this investigation, you will answer the investigation question:

Which chocolate melts the fastest: white, milk or dark?

You will need to choose one method to melt your chocolate:

## Method 1

You will need:

- chocolate – 1 piece of white, milk and dark
- plastic re-sealable bags x 3
- stopwatch
- use of hands

Instructions

1. Place one piece of chocolate into each plastic bag and seal.
2. Have one member of your group place one bag in their hands and cover the whole piece of chocolate.
3. Keep the chocolate covered by the hands until the chocolate melts.
4. Have another member of your group start the stopwatch.
5. Stop timing when the chocolate has melted.
6. Record the time in the table.
7. Repeat the method for the next two pieces of chocolate.

## Method 2

You will need:

- Chocolate – 1 piece of white, milk and dark
- Paper plates x 3
- Stopwatch
- Access to direct sunlight

Instructions:

1. Place one piece of chocolate onto each paper plate.
2. Place one plate into the direct sunlight.
3. Start the stopwatch
4. Stop timing when the chocolate has melted.
5. Record the time in the table.
6. Repeat the method for the next two pieces of chocolate.

You will need to make a prediction about which type of chocolate will melt the fastest.

You will need to follow the instructions to melt your chocolate.

Write or draw your observations.

Identify which chocolate melted the fastest.

Share your findings.



# Year 3 | WHICH CHOCOLATE MELTS THE FASTEST: WHITE, MILK OR DARK?

Name: ..... Class: ..... Date: .....

## 1. Write your prediction

I think that the \_\_\_\_\_ chocolate will melt the fastest  
because \_\_\_\_\_

## 2. Follow the instructions to melt your chocolate.

Our group chose method: \_\_\_\_\_

## 3. Record the time each piece of chocolate takes to melt.

Type of chocolate	Time taken to melt
White	
Milk	
Dark	

## 4. Write or draw what happened during the investigation.

## 5. Write down why you think the chocolate melted the fastest.

I think that the \_\_\_\_\_ chocolate melted the fastest  
because \_\_\_\_\_



# THE CHICKEN AND THE EGG

A staple wholefood and ingredient, eggs have the highest nutritional protein of all food sources.

Egg consumption in Australia has grown about 30 per cent over the past decade to 213.5 eggs per capita, magnified by the growing population and a significant increase in egg production.

The egg industry is small but dynamic within the Australian agrifood sector. The latest figures show the industry produced 392 million dozen eggs in 2011 with a gross value of production of \$572 million at the farm gate and \$1.595 billion at market. The industry comprises about 370 commercial egg farmers who manage more than 12 million laying hens, with the majority of eggs produced in New South Wales, Queensland and Victoria, followed by Western Australia, South Australia and then Tasmania. The Australian egg industry represents about 0.25 per cent of global production.

Cage systems, where birds are permanently housed in cages within a shed, are the most common, producing 55 per cent of the retail volume. They are also the most efficient, enabling eggs to be produced at a lower cost to consumers. The other two production systems are barn systems (nine per cent of the retail volume), where birds are free to roam within a shed, and free range (34 per cent), where birds are housed in sheds but have access to an outdoor range. While consumer demand for eggs produced under these conditions has increased, best management practices and on-farm hen husbandry remain the most important factors in shaping community attitudes towards the industry, particularly in relation to bird stocking densities.

Most eggs are graded then packed ready for distribution to retail, foodservice and export markets. Processing into egg liquid/pulp or powder for export or foodservice distribution to food manufacturers is the other main channel to market.

The major components of eggs are the yolk, the egg white, shell membranes, which prevent bacteria entering the egg, and the shell, which protects the egg.

Eggs provide 11 different vitamins and minerals, high-quality protein, healthy fats (including omega-3s) and important antioxidants. Research shows consumers have higher intakes of vitamins A, E, B12 and folate compared with non-egg consumers. The Egg Nutrition Council supports the inclusion of six eggs a week in a well-balanced diet and the Australian Dietary Guidelines confirm that consumption of eggs every day is not associated with an increased risk of coronary heart disease, dispelling a long-held myth. In fact, omega-3s can significantly benefit the heart and blood vessels.



## DID YOU KNOW?

- Fresh eggs stored in their original carton in the refrigerator will keep for six weeks from the packing date, whereas eggs age seven times faster when left on the bench.
- Fresh eggs sink to the bottom of a bowl of water while older eggs float because of the large air cell that forms in their base.
- The perfect poached egg is cooked for three to four minutes.
- A serve of eggs provides the same amount of kilojoules as two small apples (seven per cent of a person's daily energy needs).







Lesson plan: Year 4

# WHICH CAME FIRST — THE CHICKEN OR THE EGG?

## Introduction

In this lesson, students explore the concept that living things have life cycles and identify that plants and animals have similar patterns of development. They describe the stages of development of a living thing, such as a chicken and make and record observations of living things as they develop through their life cycles.

## Australian Curriculum content descriptions

### Science Understanding

#### Biological sciences

Living things have life cycles ([ACSSU072](#))

#### Science as a Human Endeavour

##### Nature and development of science

Science involves making predictions and describing patterns and relationships ([ACSHE061](#))

#### Science Inquiry Skills

##### Questioning and predicting

With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge ([AC SIS064](#))

##### Planning and conducting

Safely use appropriate materials, tools and equipment to make and record observations, using formal measurements and digital technologies as appropriate ([AC SIS066](#))

##### Processing and analysing data and information

Compare results with predictions, suggesting possible reasons for findings ([AC SIS216](#))

##### Communicating

Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports ([AC SIS071](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 4, students** apply the observable properties of materials to explain how objects and materials can be used. They use contact and non-contact forces to describe interactions between objects. They discuss how natural and human processes cause changes to the Earth's surface. They describe relationships that assist the survival of living things and **sequence key stages in the life cycle of a plant or animal. They identify when science is used to ask questions and make predictions.** They describe situations where science understanding can influence their own and others' actions.



**Students** follow instructions to identify investigable questions about familiar contexts and predict likely outcomes from investigations. They discuss ways to conduct investigations and safely use equipment to **make and record observations**. They use provided tables and simple column graphs to organise their data and identify patterns in data. **Students** suggest explanations for observations and compare their findings with their predictions. They suggest reasons why their methods were fair or not. **They complete simple reports to communicate their methods and findings.**

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](http://acara.edu.au)).

## Background information

### Information on the lifecycle of chickens

Chickens are domestic animals and cannot fly. Adult chickens are known by two different terms – males are called roosters and females, hens. Young chickens are called chicks. Chickens range in colour from white to brown and other colours, including black. Roosters are more colourful than hens.

Hens lay eggs and eggs start as a yolk inside the ovary of the hen, being released into the oviduct, which is a long, spiralling tube. It is here that the yolk can be fertilised by the sperm from a rooster. As the egg travels down the oviduct, it becomes covered in a membrane called the 'vitelline membrane' as well as structural fibres and layers of albumin (the egg white). The egg continues down the oviduct and the structural fibres become twisted to anchor the egg white to the yolk. The eggshell is then deposited in the lower part of the oviduct and takes approximately 17 hours to form (out of the 24 hours for the complete egg's development). The shell is made of calcite.

If the egg becomes fertilised, the chicken embryo develops inside the egg and the life cycle takes approximately 21 days after being laid. The yolk provides the food and water required for the chicken to grow. The hen sits on the egg to keep it warm and turns it to prevent the yolk from crushing the chick against the shell.

Once the egg is ready to hatch, the chick uses a specially grown 'egg-tooth' to break a hole in the shell. This is called the 'pip'. The chick then continues to peck its way out of the egg until the egg is cracked all the way around – this is called the 'zip'. The chick continues to wriggle until it is completely hatched. Once hatched, its feathers dry off and it becomes fluffy. This process can take anywhere from between 5-6 hours up to 12-24 hours. After a few days, the egg-tooth falls off. Young female chickens are called pullets and young males, cockerels.

### Life cycle information

A life cycle is the term used to describe the series of changes that happen to a living thing over its lifetime. It can be illustrated in a simple, linear form but is generally depicted in circular form. This enables the development to be described as the continuing cycle of birth, growth, reproduction and death of a living thing. Animal young are typically similar to the parent. Fish, mammals, reptiles and birds have similar patterns of development; however amphibians such as frogs have a more complex life cycle. Other animals such as butterflies undergo a complete metamorphosis including an egg, larval, pupal and adult stage.

## Materials and equipment

### Per class:

- eggs – variety of sizes or colours if possible
- images of a baby, child and adult – these can be photographs or sourced from a magazine



### Per student:

- plastic cup per student
- paper towel
- bean seed or other fast growing seeds such as mustard cress or radish
- water

## Teaching sequence

### Lesson objective

In this lesson students will explore the life cycles of living things and recognise that all living things have similar patterns of development.

### Introduction

Show students pictures of a baby, a child and an adult and ask students to discuss familiar ideas about stages of development and list their responses.

Explain how all living things move through stages of development and that they follow similar patterns of development – baby to juvenile to adult.

Explain that simple stages of development are generally illustrated in a linear fashion.

Have students participate in the learning object [Part of a pattern](#) to explore patterns of development of a variety of living things.

Ask students to make observations about how these stages of development were illustrated (as a cycle or circle).

### Core

1. Display the time-lapse video [Broad bean seedlings emerging from soil](#) to illustrate the stages of development of a plant. Pause the video at different points to discuss and make observations of the plants.
2. Explain that a good way to observe lifecycles is to actively participate in the growth of a plant or to observe an animal growing.

**Ideas for further learning** – have students participate in an investigation where students grow their own cress/radish plants. (Mustard cress and radish are fast growing)

3. Inform students that they will now be exploring an animal's life cycle. Show students the egg or eggs and ask them to make predictions about which animal's life cycle they will be exploring. (Chicken)
4. Inform students that the chicken is a domestic (farm) bird that cannot fly and that a male chicken is called a rooster and a female is called a hen.

**Ideas for further learning** – explore the different breeds of chickens including breeds such as the Australorp, Bantam, Leghorn, Silkie and Araucana (Easter-egger) and/or investigate the different types/colours of eggs chickens can lay including white, brown, olive, green and blue.

5. Ask students to discuss ideas about a chicken's life cycle and list their responses.
6. Ask students to make suggestions about a similar life cycle pattern from the ones they have explored in the learning object 'Part of a pattern' earlier in the lesson to explain their reasoning.
7. Inform students that an egg starts as a yolk inside the mother hen. The yolk is released into a long, spiralling tube inside the hen called the oviduct, where it develops an eggshell before it is laid.



**Idea for further learning** – explore the formation of the egg within the oviduct.

8. Ask students to make predictions about what happens once the egg is laid.
9. Explain to students that the chicken's life cycle:
  - involves a number of stages of development that starts once the hen lays a fertilised egg.
  - takes approximately 21 days from laying to hatching. The hen sits on the eggs at this time to keep them warm.
  - involves the baby chick developing inside the egg over this period of time – the yolk inside the egg nourishes the chick as it develops.
10. Show students the [images of the chick's development inside the eggshell](#).
11. Explain to the students that once the chicken has fully formed inside the shell, it is time for it to hatch and that this can take anywhere from 5-6 hours up to 12-24 hours from 'pip to zip'. The chick has a small 'tooth' on its beak that helps them crack out the shell. The egg tooth drops off a few days after hatching.
12. Show students the video of [baby chicks hatching](#) and ask students to discuss what they observe.
13. Remind students that life cycles are illustrated using diagrams that form a circle and that they have viewed examples of these when exploring the learning object, [Part of a pattern](#).

**Ideas for further learning** – jointly construct a life cycle diagram of another living thing.

14. Ask students to draw a life cycle diagram of a chicken to demonstrate their understandings. Use the worksheets [Stages of a chicken's life](#) to confirm these life stages.

**Idea for further learning** – participate in a chicken-hatching program at your school. Consider this when planning for the lesson sequence. If participating in hatching programs, explain to students the ethical responsibilities in looking after vertebrate animals such as chickens.

## Conclusion

Inform students that all bird (avian) life cycles follow the same pattern of development as that of a chicken and that all birds lay eggs, but that these eggs can vary in size and colour quite significantly. The hummingbird lays the world's smallest egg and the ostrich lays the biggest egg.

Ask students to make suggestions about other birds' life cycles they might like to investigate.

Finally, ask students to consider the question 'Which came first, the chicken or the egg?'

## Lesson resources

### Digital resources

R11802 [Broad bean seedlings emerging from soil](#), NDLRN (0.33 min)

L1472 [Part of a pattern](#), NDLRN

[All about chickens](#), Enchanted Learning

[Baby chicks hatching](#), Museum of Science and Industry Chicago (1.30 min)



## Worksheets

[Stages of a chicken's life](#), English for the Australian Curriculum

[Detailed life cycle of a chicken](#), English for the Australian Curriculum

(These sheets are from the unit of work *Investigating eggs in stories and science* in Useful links below)

## Useful links

[Classroom activities – The Magic School Bus cracks a yolk](#), Scholastic. Lesson ideas and activities

[Henny Penny Hatching](#), Chicken hatching program

[Investigating eggs in stories and science](#), English for the Australian Curriculum. Unit of work

[Living Eggs](#), Chicken hatching program

[Our chickens hatching!](#), You Tube (2.21 mins) Film clip





# SEED COLLECTIONS FOR OUR FUTURE

The variety of plants grown for food has dramatically declined in the past 30 years with the globalisation and intensification of agriculture. While this has been necessary to lift the immediate quantity of food, scientists know it is not sustainable.

Humanity cannot risk diminishing the biodiversity of edible flora. Varieties of wheat, lentil or potato, for example, can disappear as permanently as the dinosaurs, yet they may contain the very genes needed for future crops to cope with environmental stresses such as pestilence or climate change.

Extinction can and does affect the flora that feeds the world. A network of international researchers is dedicated to conserving crop biodiversity; at the heart of which are the seeds of every known edible plant.

A seed is a nutritious food store feeding (upon germination) an embryo in which exists the plant's DNA, along with epigenetic modifications (acquired responses in the DNA to environmental influences) and the embryo's ability to develop all of the plant's specialised cell types. These are the culmination of countless evolutions, selections and adaptations. A seed is a time capsule, carrying into the future eons of genetic heritage and survivability.



As early humans found, seed can be stored and saved if it is kept cool and dry to postpone germination while still maintaining the embryo's viability. Today, sophisticated versions of

those same techniques are used to stockpile seed in 1400 genebanks in 100 countries. A duplicate of all of these collections is also housed in the Svalbard Global Seed Vault in Norway inside the Arctic Circle as insurance against any doomsday scenario that wipes out other seed storages. Conserving crop biodiversity begins with collection missions into remote regions where the wild ancestral relatives of modern crop plants still survive, in particular the Central Asia Caucasus region where crop domestication began.

The International Treaty on Plant Genetic Resources for Food and Agriculture allows countries to cooperate, conserve, exchange and sustainably use the world's plant genetic resources without fear of commercial or political exploitation. Australia has ratified the treaty and recently centralised its own seed collections of cereals (such as wheat, barley and maize) and pulses (peas and beans) in the Australian Grains Genebank in Horsham, Victoria. The facility will hold up to 180,000 samples from Australia and around the world, and also house the research teams that will put this genetic resource to work breeding the crops needed to cope with changing environmental circumstances and to contribute to more sustainable farming practices.



## DID YOU KNOW?

- More than 7000 plant species have historically been used in human diets; however, less than 150 species are grown commercially today. Only 12 plant species represent the major vegetables on today's menus.
- Within each plant species a high number of varieties and great genetic diversity may be found. For example, there are more than 100,000 varieties of rice.
- The Svalbard Global Seed Vault has the capacity to store 4.5 million different seed samples, with each sample containing about 500 seeds.



Lesson plan: Year 5

# INVESTIGATING FACTORS THAT INFLUENCE SEED GERMINATION AND PLANT GROWTH

## Introduction

During this lesson, students examine and compare features of plants and discuss why it is important to study the growth and development of plants. Students explore factors that affect plant growth and conduct an investigation into how coloured light affects the growth of plants. Students will explore how plants are used in our daily lives and discuss how studying plants and factors that influence their growth could help manage food resources for the future.

## Australian Curriculum content descriptions

### Science Understanding

#### Biological sciences

Living things have structural features and adaptations that help them to survive in their environment ([ACSSU043](#))

### Science as a Human Endeavour

#### Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena ([ACSHE081](#))

#### Use and influence of science

Scientific knowledge is used to inform personal and community decisions ([ACSHE217](#))

### Science Inquiry Skills

#### Questioning and predicting

With guidance, pose questions to clarify practical problems or inform scientific investigation, and predict what the findings of an investigation might be ([AC SIS231](#))

#### Planning and conducting

With guidance, plan appropriate investigation methods to answer questions or solve problems ([AC SIS086](#))

Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate ([AC SIS087](#))

Use equipment and materials safely, identifying potential risks ([AC SIS088](#))

#### Processing and analysing data and information

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate ([AC SIS090](#))

Compare data with predictions and use as evidence in developing explanations ([AC SIS218](#))



## Communicating

Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts ([ACSI093](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 5, students** classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They **analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives** and how science knowledge develops from many people's contributions.

**Students follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe** and improve the accuracy of their observations. **Students construct tables and graphs to organise data** and identify patterns. **They use** patterns in **their data to suggest explanations and refer to data when they report findings. They** describe ways to improve the fairness of their methods and **communicate their ideas, methods and findings** using a range of text types.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Background information

Growth in plants depends on a variety of factors both extrinsic and intrinsic. Green plants require minerals and other essential elements for normal growth and development. These nutrients come from the soil and the growth of plants is affected by the amounts of nutrients in the soil. Water is also an essential requirement for plant growth right from the early stages of growth. Water is essential for plants to complete photosynthesis and without water, plant growth and functioning is severely impaired. Oxygen is also an essential requirement as it is necessary for cellular respiration in plants, and directly affects growth processes. Plants are also greatly influenced by temperature and variation in temperature of the soil in which they grow and in the surrounding environment. Most plant species prefer temperature in the range of 20°C – 40°C. Light also influences the growth processes of plants. Plants that grow well under bright, direct sunlight are called photophilic plants. Plants that prefer low light conditions are called photophobic. Light also affects the stems and leaves of plants – plants growing in darkness are often characterised by long, weak stems and leaves that are underdeveloped, pale and yellow.

## Materials and equipment

### Per group:

- 3 plastic cups
- soil, potting mix or paper towel. Choose medium that will support growth for your chosen seeds.
- fast growing seeds such as mustard cress or radish – available from your local nursery or hardware store. (Interesting alternative plants to study include wheat or wheatgrass. These are available online or in wholesale produce stores. Search your local area for stockists.)
- water
- 1 cardboard box
- squares of coloured cellophane paper – yellow, red, green and blue



- tape and scissors
- access to strong lights – lamps or fluorescent lights

## Safety advice

When carrying out plant growth investigations follow school or sector guidelines when working with potting mix.

Consider sun safe practices when working outdoors.

Remind students not to taste plant materials.

## Teaching sequence

### Lesson objective

In this lesson students investigate factors that influence plant growth, including environmental factors, and plan and conduct an investigation into the effect different coloured light has on the growth of plants.

### Introduction

Show students the [images of plants](#) at the end of this lesson and ask them to make comparisons between them. Look at the shape of their leaves, stems, trunks or branches and their colour. Ask students to list their responses and share their ideas with others.

Discuss how plants have structural features that enable them to survive in their environment.

Point out to students the images of the Cactus and Elephant Ear and ask them to look at the structure of their leaves and to make suggestions about how these structures help the plants to survive in the environments in which they grow.

Explain that the structure of the cactus plant allows it to survive harsh heat and poor water supply; it has a fleshy stem that allows it to store water, it has spines that are modified leaves that minimise the loss of water. In comparison, the Elephant Ear has large leaves to catch as much of the sun's rays as possible to allow for photosynthesis.

Explain that scientists study plants in order to understand their development and this allows communities to use this knowledge to make decisions such as which crops to plant on a farm.

Inform students that they are going to conduct a study of some fast-growing plants and investigate factors that affect their growth.

### Core

1. Ask students to discuss and list the process for conducting investigations. Clarify that they should be conducting a fair test. Review the concept of fair testing ie changing only one variable, measuring another and keeping the rest the same.

**Ideas for further learning** – Use the learning object [Fair test](#) to introduce students to or remind students how to conduct a fair test.

2. Ask students to list factors that influence the growth of plants such as temperature (too much or too little heat), lack of water and/or planting medium (soil or sand).
3. Explain to students that they will be conducting an investigation that looks at the effect that different coloured lights have on the growth of plants.
4. Ask students to make suggestions about how they might need to conduct the investigation and list their responses.



5. Distribute the worksheets [Plant growth investigation](#) and [Plant observations](#) at the end of this lesson. The latter is for students to record their observations. Explain that they will:
  - need to work in groups
  - need to follow the instructions to conduct the investigation
  - set up a 'control' plant to observe and compare
  - place their plants inside the box with the lights shining through the coloured cellophane.
6. Ask students to collect their equipment and to commence the set-up of the investigation.
7. Explain to students that once they have set up their investigation, they will be required to study the plants over the following week and record their data.
8. Have students record the height of the plant(s) daily to track the growth over time.

**Ideas for further learning** – Have students take photographs or time-lapse video of the plants growing to enhance their observations and to form a visual diary.

9. Have students share their findings and make comparisons between groups.
10. Ask students to discuss whether their predictions matched their findings and use this to develop their explanations about the investigation.
11. Ask students to present their conclusions about the effects that coloured light has on the growth of plants.

## Conclusion

Have students view the video [Could you survive without plants?](#) and make observations about the role of plants in our daily lives.

Clarify with students that plants are an important and integral part of our lives and that it is necessary for us to understand how they grow and develop. Ask students to share their ideas and list their responses about why it is important to understand how plants grow and develop.

Explain how studying plants, and factors that influence their growth, can help us to manage our resources for the future and to provide food for people across the globe, even in times of drought or extreme weather.

Ask students to make suggestions about other factors they could investigate using plants.

## Lesson resources

### Digital resources

[Images of plants](#) (page 48)

L540 [Fair test](#), NDLRN

[Could you survive without plants?](#) ABC Splash (5.19 min)

### Worksheets

[Plant growth investigation](#) (page 49)

[Plant observations](#) (page 50)

[Images of plants](#) (page 48)





Year 5 | INVESTIGATING FACTORS THAT INFLUENCE SEED GERMINATION AND PLANT GROWTH



**Tomato seedlings** (<http://mrg.bz/0aOYBb>)



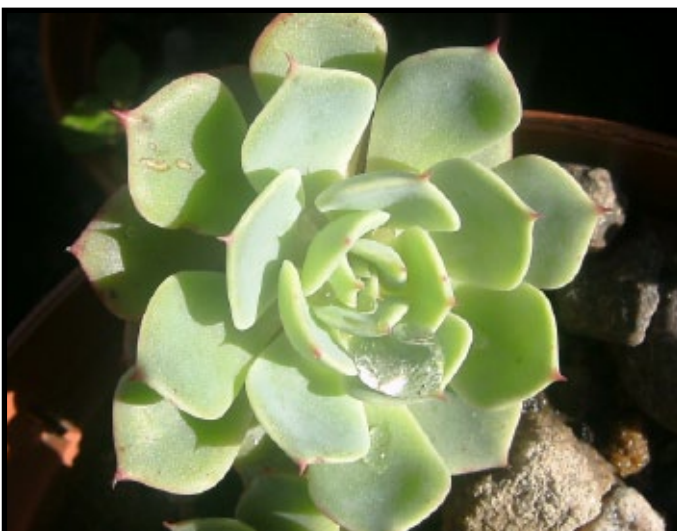
**Prickles** (<http://mrg.bz/2IPf5R>)



**Giant elephant ears** (<http://mrg.bz/xvA6Eb>)



**Palm tree** (<http://mrg.bz/rS403A>)



**Succulent** (<http://mrg.bz/gR4P4p>)



**Green beans** (<http://mrg.bz/vGrhGb>)



## Year 5 | INVESTIGATING FACTORS THAT INFLUENCE SEED GERMINATION AND PLANT GROWTH

Name: ..... Class: ..... Date: .....

# Plant growth investigation

During this investigation, you will explore how coloured light affects the growth of plants.

This investigation takes place in 2 parts:

- Part 1 – preparation and growth of the seedlings
- Part 2 – investigating the effect of coloured light

You will need:

- plastic cups x 3 (per group)
- planting medium
- seeds
- water
- access to sunlight
- large cardboard box
- coloured cellophane paper
- scissor and sticky tape

## Instructions Part 1 – preparation and growth of the seedlings

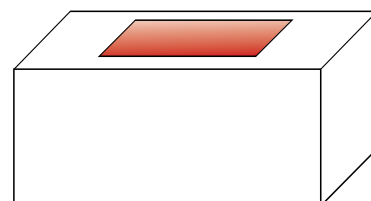
Preparing the seedlings

1. Place some planting medium into each cup, filling it about half full.
2. Plant your seeds into the soil and make sure they are covered by the soil.
3. Place your seeds in a sunny, warm position.
4. Water the seeds daily.
5. Make observations of the seeds growth.
6. Record your observations. Use the sheet – Plant observations to help you.
7. When the plants have broken through the soil, proceed to Part 2.

## Instructions Part 2 – investigating the effect of coloured light

Preparing the cardboard box:

1. Turn your cardboard box upside down.
2. Cut out a hole out of the middle of the bottom of the box.
3. Tape a large square of coloured cellophane to the inside of the box, so that the entire hole is covered. Your cardboard box should look similar to the example, below right.
4. Place one plant back in the same warm, sunny position. This is the control plant.
5. Place one plant in a dark cupboard.
6. Place one plant under the box and place back in the sunlight OR under a direct lamp.
7. Make a prediction about what you think will happen to each plant.
8. Record your predictions in your science journal.
9. Continue to water your plants daily.
10. Make observations of each plant daily and record what is happening.
11. Continue observing all 3 plants for approximately one week.
12. Compare your findings with your predictions.
13. Document your findings and explanations in your science journal.
14. Discuss reasons for your findings.





## Year 5 | INVESTIGATING FACTORS THAT INFLUENCE SEED GERMINATION AND PLANT GROWTH

Name: ..... Class: ..... Date: .....

### Plant observations

Draw (or photograph) and label diagrams to show growth and changes you observe in your plants

<b>Date</b>  <b>Day</b>  <b>Observations (Draw or write)</b>	<b>Date</b>  <b>Day</b>  <b>Observations (Draw or write)</b>
<b>Date</b>  <b>Day</b>  <b>Observations (Draw or write)</b>	<b>Date</b>  <b>Day</b>  <b>Observations (Draw or write)</b>





# MANAGING DROUGHT AND CLIMATE CHANGE

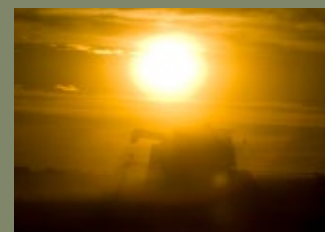
Australia is a world leader in dryland farming; its agriculture accounts for just 55 per cent of national water use compared with the global average of 80 per cent. Over the past 15 years, average annual rainfall over southern and western Australia has fallen by 20 per cent. Impact analysis of climate change indicates this drying trend will continue. Advances in plant breeding and on-farm agronomy have enabled major food industries such as grains to withstand this deteriorating climate situation.

The ability to produce higher yields from less rainfall is today an overarching theme in agricultural science. It is being achieved through advances in a range of sciences – genetics, soil biology, agronomy, engineering (including robotics, satellite guidance and remote sensing technologies) – and tighter control over water-stealing weeds. Collectively these form a body of advanced agricultural research with a common goal – ‘water-use efficiency’ (WUE). Australian science in agricultural WUE is among the most advanced on the planet, and its knowledge is also shared with poorer countries.

The biggest impact on WUE has been the advance in ‘conservation agriculture’. This has three primary characteristics: minimum soil disturbance (no tillage); old crop stubble left standing to protect against soil moisture evaporation before decaying into soil-enriching humus; and diversified crop rotations to naturally break disease cycles and, in the case of legumes and pulses, naturally fix nitrogen into the soil.

As conservation agriculture has evolved into being the mainstay of Australian dryland cropping, farmers are today able to produce about two tonnes per hectare of wheat even as average annual rainfall falls to 200 millimetres – the demarcation point that defines deserts.

Added to this new agronomy, advances in breeding are delivering crops and pastures able to better tolerate water scarcity and its common adjunct: rising temperatures. Plant breeders achieve this by screening variation in the genetic make-up of plants that have adapted already, through natural selection, to dry conditions. Some of this genetic resource is found in seed, or gene, banks and some is sourced through expeditions to the origins of agriculture in the Central Asia Caucasus region to collect wild ancestors of the plants that have become today’s farmed crops. An example of such a genetic discovery is a set of genes that keeps leaves green under drought conditions. This trait, discovered in an Ethiopian sorghum variety, allows the plant to keep photosynthesising and producing grain when it would otherwise die.



## DID YOU KNOW?

- There are four types of drought:
  - Meteorological: referring to a lack of precipitation.
  - Agricultural: referring to a lack of moisture in the soil where crops grow.
  - Hydrological: referring to low levels of water in lakes and reservoirs.
  - Socio-economic: referring to water shortages affecting people in society (drinking water, running water).
- Of all the water on earth, only 0.003 per cent is available fresh water that is not polluted, trapped in soil, or too far underground.
- Since the 1970s, the percentage of Earth’s surface affected by drought has doubled. Global warming is largely blamed.



Lesson plan: Year 6

# DROUGHT-PROOF SOILS

## Introduction

Scientists are involved in solving real world problems but they are also frequently working to prevent or mitigate the impacts of these problems. Drought in Australia has had serious economic and social consequences particularly in the rural sector. In this lesson, students will investigate how farmers and scientists are working together to drought-proof their farms.

Students begin by examining soils from a number of different areas and compare their properties. They investigate the water retention properties of these different soil types and relate their results to the physical properties of the soils tested. Students then work with hydro-gel polymers to investigate how they are being used to increase water storage in soils.

## Australian Curriculum content descriptions

### Science Understanding

#### Earth and space sciences

Sudden geological changes or extreme weather conditions can affect Earth's surface ([ACSSU096](#))

#### Biological sciences

The growth and survival of living things are affected by the physical conditions of their environment ([ACSSU094](#))

### Science as a Human Endeavour

#### Use and influence of science

Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives ([ACShe100](#))

Scientific knowledge is used to inform personal and community decisions ([ACShe220](#))

### Science Inquiry Skills

#### Questioning and predicting

With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be ([ACSiS232](#))

#### Planning and conducting

With guidance, plan appropriate investigation methods to answer questions or solve problems ([ACSiS103](#))

Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate ([ACSiS104](#))

Use equipment and materials safely, identifying potential risks ([ACSiS105](#))

#### Processing and analysing data and information

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate ([ACSiS107](#))

Compare data with predictions and use as evidence in developing explanations ([ACSiS221](#))



## Evaluating

Suggest improvements to the methods used to investigate a question or solve a problem ([AC SIS108](#))

## Communicating

Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts ([AC SIS110](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#)).

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 6, students** compare and classify different types of observable changes to materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another to generate electricity. They **explain how natural events cause rapid change to the Earth's surface. They describe and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge is used in decision-making** and identify contributions to the development of science by people from a range of cultures.

**Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured** and describe potential safety risks when planning methods. **They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using graphic representations** and construct multi-modal texts to communicate ideas, methods and findings.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#)).

## Background information

The risk of serious environmental damage by drought, particularly through vegetation loss and soil erosion, has long-term implications for the sustainability of our agricultural industries. We need to be able to manage inevitable and periodic drought conditions more effectively. Increasing the ability of soils to store water, when there is so little available, is an important strategy.

Soils have differing capacities to retain or hold water. The ability of a soil to hold water is called its 'water-holding capacity'. This ability is based largely on the soil particle size and the amount of organic material in the soil.

South Australian scientists are using polymer chemistry to help save water and protect soils. Scientists have found that certain organic polymers can be used to stabilise soils, control erosion and increase the soils ability to hold water and nutrients.

Superabsorbent hydro-gel polymers are able to store water in the soil and then release it as the plant's roots need it. It increases moisture retention and water conservation by increasing water-holding capacity in soil so that plants can survive during droughts.

## Materials and equipment

### Per group:

- 3 x 100 g dry soil samples (sandy soil, clay-rich soil and loam soil eg potting mix) each in a zip lock bag
- 1 additional soil sample for independent investigation





- 1 bucket
- 1m string
- 3 cheesecloth squares
- hydro-gel powder or granules (from garden shop)
- 1 spoon
- 1 electronic balance
- 1 pair scissors

### Per student:

- science journal

## Safety advice

Students should wear gloves when handling soils samples.

## Teaching sequence

### Lesson objective

In this lesson, students determine the water capacity of different soil types and investigate one method that can be used to improve water retention in soils. They will use this knowledge to understand the steps being taken to mitigate the impacts of drought.

### Introduction

Discuss with the students what they know about drought in Australia.

Ask them what impact drought has on people in Australia and in what ways it can affect the economy and the environment.

Watch the film clip [Dealing with drought](#).

Ask students these follow up questions:

- Why is it important for soils to retain water in times of drought?
- What affect does lack of water have on plant growth?

### Core

Divide the class into teams of three and provide each team with the necessary equipment. (If students have access to a number of different areas to collect soils, they could take samples of the different soils themselves and dry them out.)

Have the students examine each soil sample and record their observations (texture, colour, grain size etc) in their science journals.

### Water capacity investigation

1. Ask each student to take one soil sample, remove it from the zip-lock bag and place it in the middle of a square of cheesecloth.
2. Ask them to bring the corners of the cheesecloth to the middle and tie them with a piece of string to make a small bundle. Leave an extra 10 cm or so of string so they can hold on to the string.
3. Instruct students to weigh each bundle—dry soil, cheesecloth, and string—on the electronic scales and then record the data collected by each team member in their journals.



4. Each team of students must have access to a bucket or sink of water. Ask each student to now dip the bundle of soil into the container of water by holding onto the string. They must leave it in the water until no more water can be absorbed.
5. When the students are sure that the soil bundle will absorb no more water, ask them to lift the bundle of soil up by the string and let the excess water drain from the bundle until no more will drain out. Ensure that they DO NOT squeeze the water out.
6. Ask them to now weigh the wet bundle, including the string and cloth and to calculate the weight of water the 100 grams of soil can hold. This is a measure of the water-holding capacity of the soil sample. They should now record the results in their journals.
7. Share the data for all the soil samples. Discuss and apply the results. Were any differences noted in the samples?

### Water capacity challenge

1. Ask each team to select one more soil sample.
2. Instruct students to design an investigation that will determine the effect of adding hydro-gel polymer to the soil sample has on its ability to retain water.
3. Complete the investigation.
4. Compare the results from each group.

Ask students the following questions:

- Where there differences in the amount of water retained by the soil?
- Were these differences related to soil type?
- What further tests could you do?

### Conclusion

Have a class discussion about how the results from these investigations could be used by farmers to make decisions about how to manage drought conditions.

## Lesson resources

### Digital resources

[Dealing with drought](#), ABC Splash. Film clip (1:44 min)

### Useful links

[Activities and downloads – Activity sheets](#), Soil-Net. Worksheets, fact sheets

[Building a drought proof farm](#), Live Science. Article

[Can we 'drought-proof' Australia?](#) National Museum of Australia. Information for students (PDF 1.1 MB)

[Components of Soil and Water Retention](#), Stem4teachers. Lesson plan

[EarthLabs: Drought](#), Precipitation Education NASA. Lesson plan

[Water jelly crystals](#), Steve Spangler Science, Experiment



# FISHERIES IN THE BALANCE

Any belief that the bounty of our oceans is unlimited was overturned in the later part of the 20th century when overfishing led to a measurably dramatic decline in fish stocks. Some species had been fished to the point that their populations had almost collapsed, requiring significant reductions in fishing and even total bans in some areas. Iconic species still endangered by overfishing include the Blue Whale, Southern Bluefin Tuna and Chinook Salmon. However, science-based fisheries management is building confidence that these species can recover.



One of the major challenges of fisheries science is to determine fish populations and the level of fishing that is sustainable – where 'sustainable' means the harvest can continue into the future indefinitely. Complex modelling, fish sampling and tracking (including tagging) are used to assess existing fish numbers, population

recovery rates and to set catch levels. Interactions with other marine species in the food chain and the potential effects of a changing climate on fish populations and migration are also incorporated into scientific evaluations and management decisions.

The science can be particularly challenging for global species such as Southern Bluefin Tuna, which are harvested by more than 13 countries. Scientists estimated in the 1980s that this highly sought-after species had been fished to just five per cent of its unfished population. The Commission for the Conservation of Southern Bluefin Tuna (based in Canberra) was established to ensure the species survives.

Globally, demand for fish and seafood is increasing, but the volume of seafood harvested from our oceans has, for the past decade, remained at about 90 million tonnes a year. Advances in aquaculture are helping to meet increased demand, and it is predicted that farmed fish may be the main source of fish and seafood production by 2020.

Aquaculture is both sea and land based, and an increasing amount of production is not 'sea' food at all, but freshwater fish such as Tilapia and Basa, raised throughout Asia in freshwater ponds or grown-out in river cages.

The science and management of wild harvesting and aquaculture have their own challenges. For wild-catch fisheries this includes the technology to target specific species, reducing unwanted bycatches, and the impact of fishing equipment on the wider marine environment. For aquaculture, research is looking to improve the breeding of farmed species as their genetics are better understood. There is also ongoing research into improving the way fish are farmed and developing sustainable food sources for farmed fish.



## DID YOU KNOW?

- Australia's offshore fishing territory, known as its Exclusive Economic Zone, extends 200 nautical miles out to sea and contains about 3700 known species of fish, more than 2800 species of molluscs and more than 2300 species of crustaceans. Only a small proportion of these are commercially fished and the industry is regulated by a combination of federal and state agencies.
- Australia's commercial fishing and aquaculture industry is worth about \$2.2 billion annually and employs 11,600 people.
- The average global consumption of fish per person is 30 kilograms a year. Australians consume about 25 kilograms per person per year.



Lesson plan: Year 7

# SUSTAINABLE FISHING

## Introduction

Modelling relationships is an important skill and is frequently used by scientists to examine the impacts of changes upon a system. This can be used to examine the impact of human intervention upon the sustainability of fishing in a particular area.

In this lesson, students model a community of fishermen looking at their needs in order to sustain their families and to make a successful living and the resulting short term and long-term impact on their environment. Students examine the concept of sustainability and the effectiveness of modelling as a tool for scientists to understand and predict the impact of certain activities upon the environment.

## Australian Curriculum content descriptions

### Science Understanding

#### Biological sciences

Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions ([ACSSU112](#))

Some of Earth's resources are renewable, but others are non-renewable ([ACSSU116](#))

### Science as a Human Endeavour

#### Nature and development of science

Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world ([ACSHE134](#))

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science ([ACSHE226](#))

#### Use and influence of science

Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations ([ACSHE120](#))

Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management ([ACSHE121](#))

### Science Inquiry Skills

#### Questioning and predicting

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge ([AC SIS124](#))

#### Planning and conducting

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed ([AC SIS140](#))



## Processing and analysing data and information

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate ([AC SIS144](#))

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions ([AC SIS145](#))

## Communicating

Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate ([AC SIS148](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 7, students** describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They **analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth systems. They predict the effect of environmental changes on feeding relationships** and classify and organise diverse organisms based on observable differences. **Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.**

Students identify questions that can be investigated scientifically. They plan fair experimental methods, identifying variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. **Students draw on evidence to support their conclusions. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods.** They communicate their ideas, methods and findings using scientific language and appropriate representations.

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Background information

Sustainable fishing involves removing fish from an environment at a rate no faster than it is able to replenish itself. To ensure the long-term sustainability of fish stock, it is important that enough of each species remains to reproduce and replace the numbers that are removed through fishing and those that die through natural mortality (ie dying of old age, sickness or through predation).

The impact of limiting the numbers and size of fish caught not only affects the lives of those who eat the fish, but also the lives of those who fish to keep their families alive or to make a living for themselves. The method of fishing used is one way of controlling the numbers of fish removed from their environment. The use of a single fishing rod, with or without technology, allows for a single fish to be caught at a time. Trawling, the pulling of a net (trawl) behind a boat, not only catches large numbers of fish at a time, but can also be detrimental to the local environment by damaging sea grasses and disrupting the local habitats for other marine life.



## Materials and equipment

### Per group:

- 20 sugar-coated chocolates
- 10 large jelly beans
- tray
- spoon
- 3-4 straws
- stopwatch

## Safety advice

Students should be reminded of the rule of not eating in the science lab. Alternatively, a normal classroom could be used.

## Teaching sequence

### Lesson objective

In this lesson, students assess the non-renewable nature of fish populations and how human activity can affect their population and ultimately human food supplies.

### Introduction

Ask students if they eat fish and chips. Ask students if they know what type of fish their local fish and chip shop commonly uses. Include questions such as: Where does this fish come from? How is it caught? Where are fish placed in a marine food web?

### Core

1. Divide students into groups of 3–4. Each student represents a fisherman who needs to catch fish to eat or sell to make a living.
2. Each student should be given a straw (representing a fishing rod) and each group an ocean tray containing 20 sugar-coated chocolates and 10 large jelly beans representing small fish and large fish respectively. Give students 20 seconds to 'suck up' the fish using their straw. Students' hands should be behind their back during this first 'fishing season'. The student fishermen need to catch a minimum of two fish to survive the season. If they fail, they will sit out the next season.
3. Distribute the following table to each group. Students should record in line 1 of the table how many fish are caught and how many are left at the end of the season.

	Season	Number of 'fish' caught	Number of 'fish' left in the ocean tray
1	Straws with no hands		
2	Straw with hands		
3	1 spoon in group		

4. The fish remaining on the tray are available for breeding. Add one new fish for every fish remaining on the tray ie if there are 3 sugar-coated chocolates and 4 jelly beans left, add another 3 sugar-coated chocolates and 4 jelly beans.





5. In season two, students are allowed to use their hands to direct the straws. Explain to students that this represents experienced sports fishermen with new technology. Once again students have 20 seconds to catch their minimum of two fish to survive.
6. Students should count and record in line 2 of the table the number of fish caught and the number of fish remaining in their ocean tray. As in step 4, add more 'fish' as necessary to represent their increased numbers through breeding.
7. Discuss with the students the effect of improved fishing technology on the fish populations. Ask students for suggestions of how the fishermen could survive if the fish are all caught.
8. Give one student in each ocean group a spoon (representing a trawling net) to catch fish. Once again students have 20 seconds to catch fish. If a group runs out of fish, quietly suggest they invade another group's ocean tray to catch their required two-catch minimum.
9. Record the results in line 3 of the table.
10. Discuss which was the most effective method of fishing. Ask students: Was this method sustainable? What does sustainable mean? What was the reaction of other fishermen when other groups invaded their ocean?
11. Brainstorm rules or guidelines that would make fishing sustainable.
12. Replay the game with the new rules.

## Conclusion

Suggest to the students that they just created a model of the sustainability of fishing. Ask students how closely their model related to real life.

As a class discuss the advantages and disadvantages of such modelling techniques in science.

## Lesson resources

### Useful links

[Australia's sustainable seafood guide](#), Australian Marine Conservation Society. Information for teachers and students

[Sustainable recreational fishing student activity workbook](#), Solitary Islands Aquarium, Southern Cross University (PDF, 651KB)

[Sustainable seafood guide: app for iPad](#), Australian Marine Conservation Society Inc

[Popcorn economics](#), EcEdWeb University of Omaha. Extension lesson



# WIND POWER MUSCLES UP

The wind's power has been harnessed for centuries to power machines, grind grain and pump water. Conversion of wind to an effective energy source was typified by windmills. Today's wind farms, comprising large numbers of individual wind turbines, follow the same basic principles. The turbines' blades respond to the kinetic energy of wind and turn a shaft that connects to a generator. The generator turns this mechanical energy into electricity, which is fed directly into the supply grid.

Wind power joins hydro-electricity, solar energy, wave power and geothermal energy as a natural energy option for the future. Energy sustainability – defined as meeting energy needs without undermining environmental balance or compromising the ability to meet future energy needs – is considered a crucial human goal given that fossil fuels are a finite resource and a contributor to greenhouse gases.

Although most people support renewable energy, wind farms are not always welcome because of the visual effect they have on a landscape and claims that low-frequency sound emitted by the turning blades can affect people's health. Neither international nor Australian studies have to date been able to find evidence to support these concerns.

Wind power is currently the lowest-cost renewable energy technology that can be rolled out on a large scale. Consequently, it has been the dominant form of renewable generation to attract investment.

An example of a modern wind farm's generating capability is one of Australia's newest at Macarthur in western Victoria. Completed in late 2013 it covers 5500 hectares with 140 turbines generating 420 megawatts (MW). This is enough to power 220,000 average-size homes each year.

Turbine towers 80 metres high are an example of one of the main technological developments in recent years – upscaling. Since the first commercial wind turbines in the 1980s, turbine generating capacity has increased from hundreds of kilowatts to several megawatts, made possible by the massive rotors now up to 100 metres in diameter.

In Australia, wind farms are mostly in coastal locations; however, in Europe the latest research and development is looking to take farms offshore, where the public is more supportive of new, large installations. However, offshore sites present engineering challenges, with foundations and materials needing the ability to withstand marine environments. Australia's greatest potential for offshore wind power is considered to be off its southern coastline, but for the moment, the capital, operational and management costs are considered too high.



## DID YOU KNOW?

- In 2012, Australia's wind farms for the first time produced enough energy to power the equivalent of more than one million homes.
- Wind power now supplies 3.4 per cent of Australia's overall electricity needs.
- The Mawson research station in the Australian Antarctic Territory now meets 70 per cent of its electricity needs from a small wind farm built to handle gale-force winds.





Lesson plan: Year 8

# WIND TURBINES — FRIEND OR FOE?

## Introduction

New technologies and developments in science impact us socially and economically. Scientists often have to make decisions regarding the implementation of new technologies and search for solutions to problems that are a consequence of these scientific advancements.

So far, wind supplies only a small amount of the energy consumed in Australia, but that will change if we follow the global trend. With the rapid expansion of wind farms there have been concerns raised regarding the environmental and health impacts of the wind turbines.

In this lesson, students identify how wind turbines convert kinetic energy into electrical energy. They will examine the advantages of this clean and renewable energy source for Australia. The students will then research the issues surrounding this new technology and use their understanding to argue for or against the siting of a wind farm in their local area.

## Australian Curriculum content descriptions

### Science Understanding

#### Physical sciences

Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems ([ACSSU155](#))

### Science as a Human Endeavour

#### Use and influence of science

Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations ([ACSHE120](#))

Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management ([ACSHE120](#))

### Science Inquiry Skills

#### Questioning and predicting

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge ([AC SIS124](#))

#### Planning and conducting

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed ([AC SIS140](#))

#### Processing and analysing data and information

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate ([AC SIS144](#))

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions ([AC SIS145](#))



## Communicating

Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate ([ACIS148](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 8, students** compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. They **identify different forms of energy and describe how energy transfers and transformations cause change in simple systems**. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea **and describe situations in which scientists collaborated to generate solutions to contemporary problems**.

**Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods.** They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. **They use appropriate language and representations to communicate science ideas, methods and findings in a range of text types.**

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Background information

A windmill commonly generates mechanical energy to crushing grain while wind turbines generate electrical energy.

A wind turbine is made up of two or three propeller-like blades called the rotor. The rotor is attached to the top of a tall tower. As the wind blows it spins the rotor. As the rotor spins the energy of the movement of the propellers gives power to a generator. There are some magnets and a lot of copper wire inside the generator that make electricity.

Winds are stronger higher up off the ground, so wind turbine towers are about 30 metres tall to allow the rotor to catch more wind energy. Just one wind turbine can generate enough electricity for a single house, or the electrical energy to pump water, or to power a mill that grinds grain. The electrical energy can also be stored in batteries.

Wind farms are places where many wind turbines are clustered together. They are built in places where it is nearly always windy. The electricity that is generated at a wind farm is sold to electricity companies that provide the electricity to people living in cities and towns. Wind turbines are used around the world, both on land and offshore, to capture the energy in the wind and convert it to electricity. There are already fifty wind farms around Australia. Wind energy is currently the cheapest renewable source of energy in Australia according to the Clean Energy Council.



## Materials and equipment

### Per student:

- sheet of construction paper 22 cm x 28 cm
- pencils or a single hole punch
- scissors
- 2 plastic straws
- paper clip
- glue
- wooden skewer
- string
- print out of [model turbine](#) on light A4 card
- sticky tape

## Teaching sequence

### Lesson objective

In this lesson, students compare windmills and wind turbines. They identify the basic parts of a wind turbine and explain how they work. Students will research the advantages and disadvantages of electricity generation from wind farms and use this to make evidence-based conclusions about this issue.

### Introduction

Display some pictures of windmills and wind turbines. Have students identify each and compare. Explain that windmills commonly generate mechanical energy such as crushing grain while wind turbines generate electrical energy.

Have the students [construct a model windmill](#) and use it to demonstrate wind energy being converted to mechanical energy.

### Core

1. Show or distribute a [diagram of a wind turbine](#) and discuss how a wind turbine works. Explain how it converts wind power into electrical energy. (A wind turbine has a shaft that is connected to a generator that changes the mechanical energy into electrical energy.) Also discuss the basic parts of a wind turbine: foundation, tower, nacelle and rotor. Students can [build their own model wind turbine](#).
2. View the time-lapse video of the [construction of a wind farm](#). Use this video as a stimulus to discuss where wind farms should be sited.
3. Research wind farm distribution in Australia.

### Debate

- Show pictures of wind farms and ask students for the positive and negative impacts of wind farms. Students could draw a table using the headings 'Social', 'Economic' and 'Environmental' to help them categorise these impacts.
- Organise a student debate – 'Should a wind farm should be built on local farm land'. Divide the class into interest groups and have them argue their case for or against the construction of the wind farm. Groups could include local businesses, residents, farmers and local government.



## Conclusion

Complete a pros/cons diorama for the classroom.

## Lesson resources

### Digital resources

[Windmill model science project](#), Education.com

[Wind energy](#), Renewable Global Energy

[Build a model wind turbine](#), CSIRO Education

[Waterloo Windfarm time-lapse video](#), Vimeo (6.51 min)

### Useful links

[How a wind turbine works](#), Energy Matters. Information for students

[Myths and facts about wind farms](#), Future Energy. Information for teachers (PDF, 1.3 MB)

[Starfish Hill wind farm](#), Energy Education Inc. Information and images of a wind farm on the Fleurieu Peninsula, SA (PDF, 745 KB)

[Wind energy](#), Geoscience Australia. Information for teachers

[Wind power](#), Future Sparks. Information for students, fact sheets, videos





# THE FUTURE — WHERE PHYSICAL AND AGRICULTURAL SCIENCES WILL MEET

There is a vegetable garden on board the International Space Station. The 'space garden' produces summer vegetables such as lettuce, peas and radishes. In the process, methods are being developed to not only allow astronauts to grow and safely eat fresh vegetables 370 kilometres above the Earth but to also enjoy the relaxation of gardening. Throughout history, wherever humans have ventured, food crops and livestock have tagged along. The space station is humanity's most recent frontier.



To keep pace with this trend, food production systems are intersecting with advanced physical sciences (such as physics and engineering) to make agriculture possible far from traditional paddocks. By the year 2050, it is expected that nearly 80 per cent of the Earth's nine billion people will be living in cities. How to produce sufficient quantities of nutritious and locally grown food is a problem that scientists are already working to solve. With 80 per cent of the land suited for raising crops already in use – and about 15 per cent of that ruined by poor management practices – part of the solution being advocated is to incorporate food production into urban environments. One invocation of 'urban agriculture' is the 'vertical farm'.

The idea of vertical farms started in a classroom at Columbia University, in New York, as a response to food, water and energy crisis. These city-based farms employ closed-loop agricultural technologies – all water and nutrients are recycled. Vertical farms resemble hermetically sealed glasshouses stacked on top of each other in a smart building that resembles a high-rise skyscraper. Additional functions can be built into the design, such as the remediation of local water supplies.

For more extreme environments and climates – including degradation so extreme that agriculture collapses – experiments have also been conducted into growing food in 'farm biodomes'. These structures are designed to be completely self-contained and can remain indefinitely isolated from the exterior environment. Achieving this self-sufficiency requires cycling nutrients and water between the biodome's human inhabitants and crops in a closed-loop cycle. This includes composting toilets that return nutrients to crops that are then eaten and the waste composted again.

Feeding ourselves from closed-loop space, urban and domed farms is not the provenance of agricultural science alone; it requires multidisciplinary teams that include biologists, agronomists, architects, ecologists, economists, physicists, chemists and engineers. Within each discipline the technology needed to urbanise agriculture already exists. The challenge is to make all these technologies work together.



## DID YOU KNOW:

- Singapore grows only 7 per cent of the produce it consumes on just 101 hectares of remaining farmland. It is a portent for cities all over the world.
- The world's first commercial vertical farm opened in Singapore in 2012. The system is 10 times more productive per square metre than conventional farming and requires less water, labour and chemicals. Operating costs are a quarter of conventional farms and transportation costs to market are minimal.
- Producing enough food using traditional agriculture to feed the 3.5 billion people living in cities today requires a land area twice the size of South America.



Lesson plan: Year 9

# GROWING FOOD ON THE SPACE STATION

## Introduction

The link between the physical sciences and the biological sciences is not always clear. This lesson examines the properties of the colours and wavelengths of light and how they impact the growth of plants. This is correlated with the limitations of humans travelling and living in space and examines the possibility of growing plants in space.

In this lesson students determine the absorption and reflection of the different colours/wavelengths of light by plants. They examine a variety of light sources for their intensity and energy efficiency and design an experiment that tests their impact on the quality of plant growth. Students will then extrapolate their findings to growing food in space.

## Australian Curriculum content descriptions

### Science Understanding

#### Physical sciences

Energy transfer through different mediums can be explained using wave and particle models ([ACSSU182](#))

#### Biological sciences

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems ([ACSSU176](#))

### Science as a Human Endeavour

#### Nature and development of science

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries ([ACSHE158](#))

#### Use and influence of science

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities ([ACSHE161](#))

The values and needs of contemporary society can influence the focus of scientific research ([ACSHE228](#))

### Science Inquiry Skills

#### Questioning and predicting

Formulate questions or hypotheses that can be investigated scientifically ([AC SIS164](#))

#### Planning and conducting

Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods ([AC SIS165](#))

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data ([AC SIS166](#))



## Processing and analysing data and information

Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies ([AC SIS169](#))

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence ([AC SIS170](#))

## Evaluating

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data ([AC SIS171](#))

Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems ([AC SIS172](#))

## Communicating

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations ([AC SIS174](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 9, students** explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions. They **describe models of energy transfer and apply these to explain phenomena**. They explain global features and events in terms of geological processes and timescales. They analyse how biological systems function and respond to external changes with reference to interdependencies, energy transfers and flows of matter. **They describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives.**

**Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence. They evaluate others' methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.**

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))

## Background information

Light is needed for a plant to photosynthesise (using water and carbon dioxide to produce glucose and oxygen). A green molecule called chlorophyll is necessary for this process to occur.

Light energy moves in a series of waves of different lengths. The visible light we see consists of different colours with different wavelengths. The longest wavelength is red and the shortest wavelength is violet. When all colours of light are mixed together, it appears white. Black is the absence of light.



Plants appear green because they absorb all the colours/wavelengths of light except for green. (It does absorb very small amounts of green, however, most is reflected.) This means our eye 'sees' the reflected green light and therefore the plants appear green. When another colour is shone on the plant (eg light through red cellophane), the plant usually appears black as the red light is absorbed and little is reflected back to our eyes.

The most efficient wavelengths of light that can be used in space are red and blue light as these are the colours that are most absorbed by the plant. Studies show a mixture of 90% red light (for photosynthesis) and 10% blue light (encouraging plants to grow towards the light) is most effective.

The light quality needed for plant growth is determined by the intensity (strength) of the light and how long the light shines on the plant (duration). It is important to note that leaving a light on for 24 hours does not make it more efficient as plants need some period of darkness to survive effectively. Different light sources have different intensities and therefore have different levels of energy efficiencies.

Small-scale experiments growing plants have been performed in space. Initial indicators suggest the low gravity environment of space has little impact on plant growth.

## Materials and equipment

### Per class:

- torch
- blue, red, green cellophane
- plants
- large boxes of the same size
- fluorescent bulbs (cool-white, warm-white, and full-spectrum)
- potting soil
- pots
- seeds (beans, lettuce, and herbs)
- light meter
- ruler

## Safety advice

Ensure that the various lights do not become too hot when placed in the boxes with the plants, as this is a fire risk.

Planting the seeds in the soil should be done in a well-ventilated environment to ensure students do not breathe in possible contaminated soil particles.

## Teaching sequence

### Lesson objective

In this lesson students examine how the colours and intensity of light can impact plant growth and use this to understand the impact on the growth of lettuce on the space station.

### Introduction

Discuss with students how astronauts survive on the space station. What food do they eat?

Show students the film clip [Astronaut Chris Hadfield and chef David Chang test gourmet space food](#)



Ask students:

- How often does food and oxygen get delivered?
- What are the impacts for long space journeys such as a trip to Mars?
- What would space travellers need to set up a space colony on Mars or the Moon?
- Plants could supply both oxygen and food, but what do plants need to survive?

## Core

1. Define the term 'light quality' and discuss how different wavelengths of light are either absorbed or reflected, determining the colour of the objects we see.
2. Cover a torch with red cellophane and shine it on a plant in a dark room. Ask students what colour does the plant appear. Is the red light reflected or absorbed? Repeat with blue and green cellophane. Continue to ask students which colours are reflected or absorbed. The plant uses the absorbed colours for photosynthesis.
3. Inform students that the quality of the red and blue light absorbed by the plant is dependent on the intensity and duration of the light.
4. Use a light meter to compare the light intensity of different locations around the school. Ask students to find where the intensity of the light is the strongest and the weakest.
5. Discuss how the light intensity would change over the day (the duration of the light). Discuss what the best location would be for a pot of lettuce to grow.
6. Discuss how this could be replicated on the space station. Ask students what type of light globes would be most efficient for growing lettuce. (Lettuce is ready to eat straight from the plant and for this reason it is the first plant to be trialled on the space station.)
7. Conduct the activity '[Light illuminations](#)'.
8. To end the activity ask the students these questions:
  - Which light source was the most effective for growing the plants?
  - Which light source was the most energy efficient?
  - Why is energy efficiency important on the space station?

## Conclusion

Show students the film clip [NASA plans to grow lettuce in International Space Station](#).

## Lesson resources

### Digital resources

[Astronaut Chris Hadfield and chef David Chang test gourmet space food](#), YouTube (12:24 min)

[NASA plans to grow lettuce in International Space Station](#), Newsy (2:02 min)

[Light illuminations](#), Kidsgardening.org (PDF, 65KB)





# THE INVENTION OF WHEAT

The domestication in about 9000 BCE of a wild grass that produced edible grain – which we today know as wheat – was a key factor in the evolution of settlement-based societies. Eleven millennia later, wheat is grown on more land – about 240 million hectares – than any other commercial food, and supplies about 20 per cent of humanity's caloric intake.

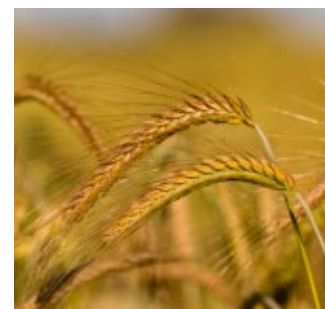
But it looks nothing like those original ancient grasses. Wheat is man-made. Bred from early grains, wheat's genetic base progressively narrowed as farmers focused their seed retention (for the next season's crop) on plants that produced more and larger grain, were more adaptable to climate and geography, and which could withstand pestilence.

Wheat is the embodiment of human achievement. However, underlying this success story is nature's genetic dexterity that allows species to diversify, hybridise, adapt and evolve. It is a capability that our earliest ancestors adeptly exploited and which scientists today mimic, with greater technical control.

Wheat is genetically extraordinary because it contains three genomes cohabitating in the same plant. Each genome is derived from a distinct wild grass species – wheat's so-called 'ancestral progenitors' – that underwent consecutive hybridisations to first produce wheat with two genomes (called durum and used to make pasta flour) and then three genomes (used to make bread flour). In the course of this natural selection only a tiny portion of each progenitor's biodiversity was captured in what became the wheat gene pool. Human selection of even rarer variants – such as the mutation that allows wheat to keep rather than disperse seed, making it easier to harvest – further narrowed the gene pool. This diminished gene set is the cost of our success, and modern-day plant breeding now needs to recover this lost biodiversity to restore to modern wheat the genetic capacity to pull humanity through what agricultural scientists see as a looming food crisis.

Over the past 25 years, science has learnt to decode inherited traits and to link variation between plants to particular differences within their DNA. This is what makes it possible for gene modification technology to manipulate the influence of single genes. However, traits of interest to agriculture are genetically complex, involving many interacting genes whose impact on the plant is also influenced by the environment.

Consequently, the most advanced biotechnology is now concentrating on understanding, measuring and potentially managing a plant's biochemical or biophysical responses to the environment. Called 'phenomics', this approach is allowing the first gains in breeding for complex traits such as resilience to climate stresses. Phenomics is humans once again reinventing wheat. This time though, biotechnology is making this process faster and more precise.



## DID YOU KNOW?

- Wheat is a member of the grass family that produces a dry, one-seeded fruit commonly called a kernel.
- Australia is the world's fourth largest wheat exporter after the US, Canada and the European Union and exports about 80 per cent of its total wheat crop each year.
- Wheat supplies about 20 per cent of the food calories for the world's people.







Lesson plan: Year 10

# THE EVOLUTION OF WHEAT

## Introduction

A case study of wheat is used to examine the evolution through natural selection.

In this lesson students examine how a single mutation of wheat thousands of years ago was a key factor in the change in human culture. Students will model the artificial selection of the mutated wheat by humans, and thereby examine the impact on humans moving from a hunting and gathering culture to a farming community and the resulting development of larger, sustainable communities.

## Australian Curriculum content descriptions

### Science Understanding

#### Biological sciences

The transmission of heritable characteristics from one generation to the next involves DNA and genes ([ACSSU184](#))

The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence ([ACSSU185](#))

### Science as a Human Endeavour

#### Nature and development of science

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries ([ACSHE192](#))

#### Use and influence of science

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities ([ACSHE195](#))

The values and needs of contemporary society can influence the focus of scientific research ([ACSHE230](#))

### Science Inquiry Skills

#### Processing and analysing data and information

Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies ([AC SIS203](#))

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence ([AC SIS204](#))

#### Communicating

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations ([AC SIS208](#))

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](#))



## Achievement standard

This lesson sequence provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

**By the end of Year 10, students** analyse how the periodic table organises elements and use it to make predictions about the properties of elements. They explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They explain the concept of energy conservation and represent energy transfer and transformation within systems. They apply relationships between force, mass and acceleration to predict changes in the motion of objects. Students describe and analyse interactions and cycles within and between Earth's spheres. They evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They **explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their review.**

Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. **Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of the methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.**

Source: Australian Curriculum, Assessment and Reporting Authority ([ACARA](http://www.acara.edu.au))

## Background information

Wild wheat was very different to modern wheat. The grains were much smaller, and readily fell from the stalk to the ground where it could germinate the next generation. This also meant it was difficult for humans to find enough individual grains to make a meal. A single mutation of the wheat meant the grain was not able to fall from the stalk as easily. In the wild, this would have meant the grain would not have had the opportunity to germinate and would have been disadvantaged in normal natural selection circumstances. However, this was an advantage for humans. It was easier for humans to collect the unfallen grains to eat or to replant for the following season. This allowed the mutated wheat to survive and (encouraged by the assistance of humans) to thrive. In turn, humans were able to collect and grow larger amounts of food, ultimately moving from a hunting and gathering society to that of farmers. This in turn allowed for larger communities to be supported in single areas. It also allowed for some members of the community to have time for pursuits other than hunting and gathering. As a result, human culture (painting, story-telling and the development of technology) was able to develop.

## Materials and equipment

### Per group:

- container with a mixture of uncooked rice and objects of different sizes representing pebbles (eg counters, dice and confetti)
- 2 sticky notes with rice stuck to sticky ends. (To prepare these pour some uncooked rice into a container. Dip the sticky end of the sticky note into the rice so that the rice sticks to it. This then represents the wheat that does not fall from the stalk. Add the sticky notes to the box.
- black permanent marker



## Teaching sequence

### Lesson objective

In this lesson students explore the impact of a single mutation in wheat on human civilisation.

### Introduction

Ask the students to write down what they have eaten over the previous 24 hours.

Get them to circle all the foods that contain wheat.

Discuss how important wheat, and the starch that it contains, is to everyday life.

### Core

1. Divide the students into small groups and explain that they are early human hunters and gathers. Give each group a prepared container of the mixture of small objects including the free 'grain' and the sticky notes with 'grain' attached. Explain to the students that the container represents an area of the ground that they must collect their food from. The rice represents the wheat needed to make flat breads etc. Give the students 30 seconds to collect as much grain as they can.
2. Ask the students to explain how they collected the food. (The grain attached to the sticky notes would be easier to collect than single grains on the ground.) Discuss the need for early hunters and gatherers to keep moving.
3. Give the students a black permanent marker to colour in the grains stuck on the sticky note and then remove them.
4. Ask the students to put half of all the 'grain' they collected in to the rubbish bin. This represents the wheat they eat. The remaining grains (including the 'black grain') will be planted to grow more food: the first farmers.
5. Discuss the characteristics of the resulting wheat crop ie will the wheat fall to the ground (uncoloured grain) or will the grains be attached to their stalk (black grains)?
6. Watch the video clip [Göbekli Tepe](#) on wheat mutation. Ask the students to write the answers to the following questions
  - How has the cultivation of wheat affected human civilisation?
  - What would have happened to the mutated form of the wheat had humans not cultivated it?
  - What services does the farmer provide for wheat to help it survive and reproduce, and how does this influence the evolution of wheat?
7. Discuss the differences between natural selection and artificial selection.
8. Discuss the similarities and differences between the artificial selection of this type of genetically mutated wheat, and the use of genetic manipulation currently being used by scientists to develop drought resistant wheat.

## Conclusion

Prepare a debate on 'We should not manipulate food by genetically modifying it.'

## Lesson resources

### Digital resources

[Göbekli Tepe](#), You Tube (9:35 min). 'How to grow a planet' series, BBC